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Reusable Launch Vehicles Operations and Maintenance Top-Down Analysis

Supplemental Report

Version 3 – September 2, 2003

Prepared for

Department of Transportation
Federal Aviation Administration
Associate Administrator for Commercial Space Transportation
AST-200 Licensing and Safety Division
800 Independence Avenue, SW
Washington, DC 20591

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Supplemental Report

Version 3 – September 2, 2003

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New	RTI/FAAC	3/31/2003	Draft Release to FAA
V1	RTI/FAAC	4/30/2003	Final Release to FAA
V2	RTI/FAAC	7/10/2003	FAA/AST Comments
V3	RTI/FAAC	9/2/2003	FAA/AST Comments

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Executive Summary

RTI was previously tasked with investigating Operations and Maintenance (O&M) activities and approaches that are practiced today by the traditional aviation domain and the Space Shuttle as they apply to Reusable Launch Vehicle (RLV) O&M. In addition, RTI was to take into account the currently envisioned Reusable Launch Vehicle (RLV) concepts, and where possible, include a review of O&M activities already being used by the early commercial RLV developers. In September of 2002, under DO2, RTI delivered a report[1] detailing the results of this investigation. That report suggested areas where O&M rules and guidelines were needed immediately to ensure public safety, and the approach that might be taken for creating such rules and guidelines.

This Supplemental Report captures the results of the follow-on research activity specifically targeted at producing O&M guideline inputs for RLVs. This report also provides additional information in topic areas covered by the original report; the results of a validation activity associated with the Functions and Procedural Items introduced in the first report; serves as a repository for data collection in preparation for a functional analysis; and, finally, discusses the synthesis of this same data into a form usable by the FAA to generate RLV O&M Guidelines.

Also during this follow-on research activity, RTI produced five volumes of *preliminary* Guideline Inputs that contain specific O&M information for use by the FAA in formulating actual RLV O&M Guidelines. It is expected that these five volumes will be developed further in subsequent work. The Guideline Inputs in Volumes 1 through 5 (General Considerations, Operations Considerations, Maintenance Considerations, Training Considerations, and Approval Considerations) are intended to serve as a common set of criteria by which both the FAA and the industry can assess O&M processes and systems to ensure public safety is protected. As such, these Volumes are considered “living” documents that will continue to mature with the RLV Industry. These five volumes and this Supplemental Report constitute the complete output of this research effort.

Research Overview

Research for this follow-on effort was focused primarily on the Functions and Procedural Items identified in the DO2 Final Report[1]. For reasons detailed in the Function Validation section of this report (Section 2.0), RTI has adopted the terms Subsystems and Functions to better describe the areas being addressed. The top-level Functions were further subdivided into sub-functions, each of which was analyzed for issues relating to maintaining public safety. Considerable effort was also expended on reviewing technical references associated with each of the Subsystems to identify specific safety-related O&M guidelines. In addition, general data collection and synthesis specifically focused on the aviation and space domains was continued. This included “Phase 2” of the Federal Aviation Regulation (FAR) and NASA Code of Federal Regulations (CFR) reviews.

It should be emphasized that each Subsystem and Function area investigated during this research could be (and often has been in the past) the subject of a dedicated stand-alone research effort. Therefore, the results put forward in this report, and the accompanying Guideline Input Volumes, should not be considered comprehensive. Rather this effort has focused on providing a broad overview where the RLV O&M issues that need inclusion when the RLV O&M Guidelines and subsequent rules are identified.

Lessons-Learned Highlights

The majority of lessons-learned during this phase of the continuing RLV O&M research effort were associated with Subsystems and Functions; however, a small number of additional items were identified during the CFR reviews. It should be noted that because this effort has expanded to focus on specific functions and subsystems, many of the lessons-learned are design dependent. The FAA will need to consider the extent that these items fall within their jurisdiction in licensing particular RLV operations.

Functional Decomposition and Validation

RTI used the Systems Functions and Procedural Items identified during previous research as a starting point for this phase. As this research continued, the language being used to describe both the System Functions and Procedural Items was further refined to clearly distinguish between physical systems that comprise or support an RLV and functions that are accomplished through use of those systems. Through this process, the original list of Systems Functions and Procedural Items was validated and changes made to ensure consistency going forward.

Procedural Items were renamed to Functions and the Systems Functions became either actual Subsystems or recategorized to Functions. Two changes were made in related Subsystem definitions: Navigation was expanded to include Guidance; and Payload/Cargo was redefined to address both Payload and Passengers.

It was determined that a general model was needed to place the Systems Functions and Procedural Items in context with the RLV development and licensing processes. The following Context Diagram, Figure 1, was developed to provide this contextual framework.

The focus of this research is represented to the right of the vertical line in the Context diagram. A number of the original Procedural Items were identified as being outside the immediate domain of O&M and are therefore denoted to the left of the vertical line. This served to better focus the functional decomposition effort. This diagram also provides a way of marrying the top-down analysis being conducted by RTI with the bottom-up analysis being accomplished internal to the FAA and is reflected in the FAR annotations in each of the blocks.

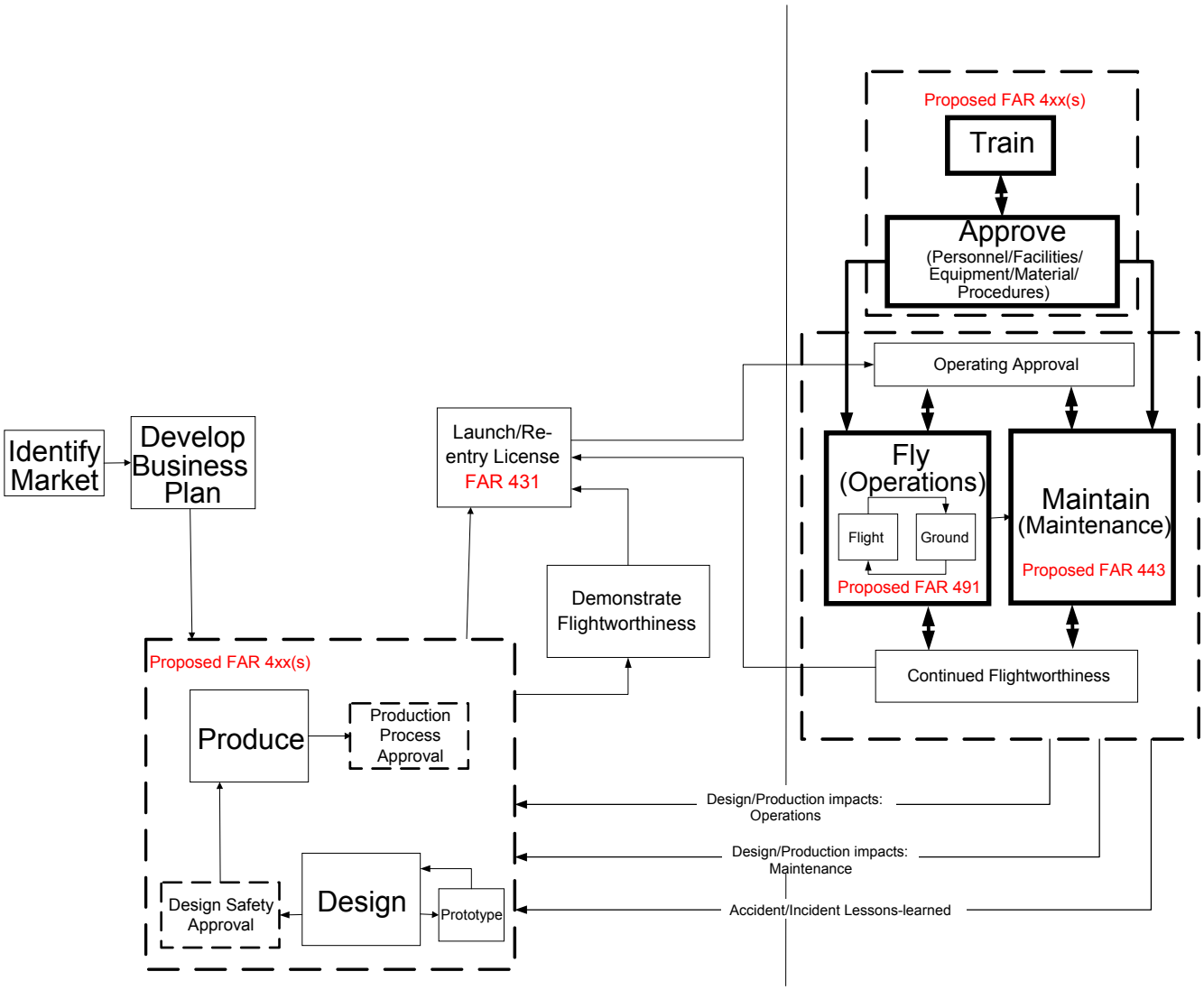

Figure 1 RLV O&M Context Diagram

From a functional perspective, this report and the related draft Guideline Input Volumes specifically focus on the Operate, Maintain, Train, and Approve functions as shown in the context diagram. Each of these major functions were further decomposed into a set of sub-functions as denoted in Figure 2. The decomposition of these major Functions are expanded and developed in Sections 2.1, 2.2, 2.3, 2.4, and 2.5 of this document. These sub-functions characterize operations and maintenance activities of an RLV and its subsystems.

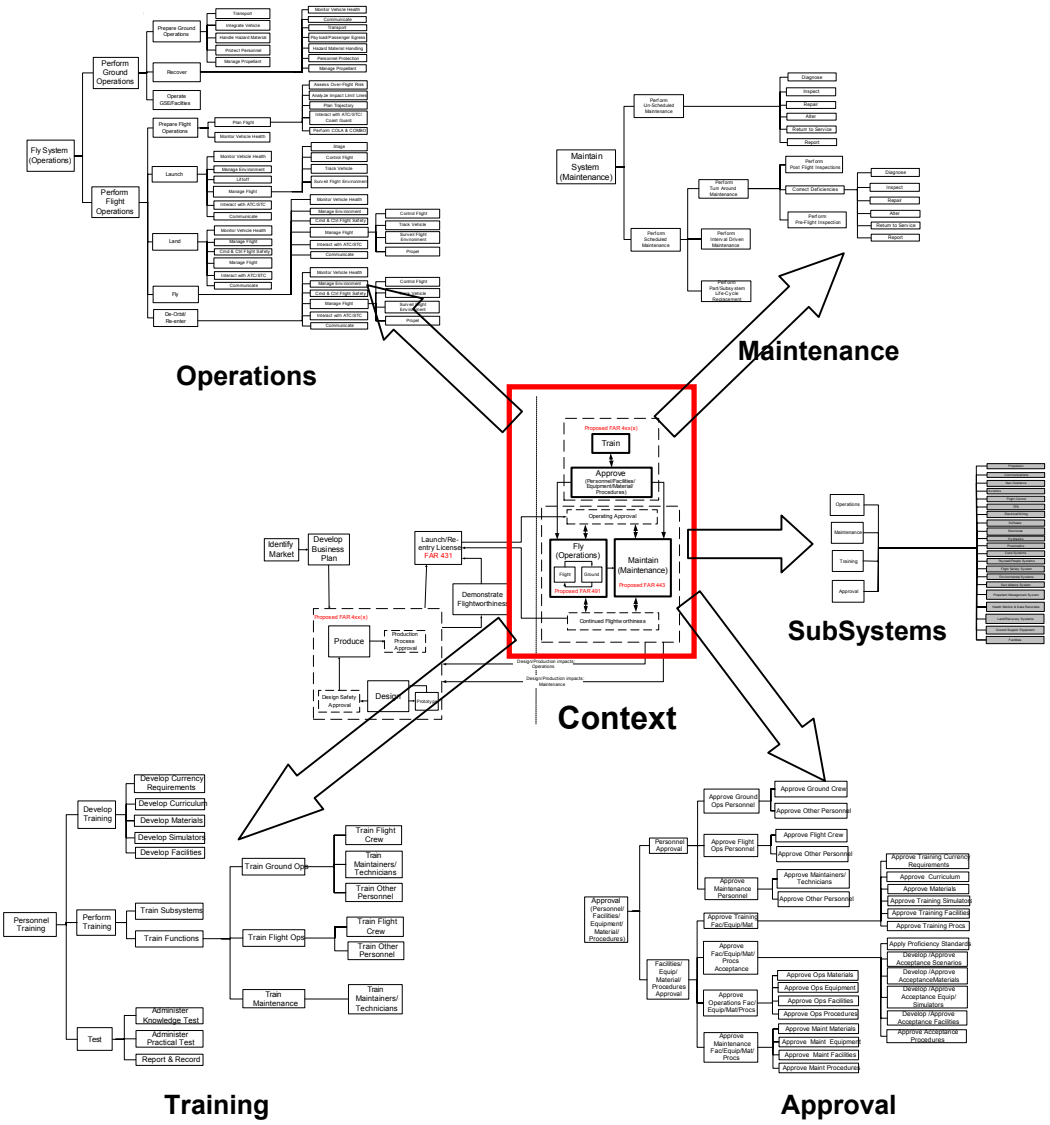

Figure 2 Decomposition Diagrams from Context Diagram

Function/Subsystem Data Collection and Synthesis

Data collection was accomplished using a set of Generic Subsystem Guideline Input Detail Sheets and Generic Function Guideline Input Detail Sheets (contained in Appendix E Guideline Input Detail Sheets). The purpose of the data capture sheets was to provide a checklist of considerations that could be used in formulating the Guideline Inputs. Specifically they capture the definition of the subsystem or function, general discussion, major issues, inter/intra agency coordination, cross-correlations with other functions and subsystems, and any additional considerations.

Next Steps

The work accomplished during this research phase, while substantial, is not all encompassing. Before a relevant set of detailed Guidelines can be developed a significant amount of additional research and data synthesis is required. However, RTI believes that the information contained in this Supplemental Report and the framework provided in the initial Guideline Inputs provides a solid baseline to build upon.

RTI purports that the next phase of this task should be focused on further refinement and expansion of the technical content contained in the initial Guideline Inputs. RTI envisions such refinement as the next logical step in achieving a workable set of Guideline Inputs that can be used in evaluating proposed RLV O&M processes and procedures.

1.0 Introduction

Many O&M activities of Reusable Launch Vehicles (RLVs) will have a direct effect on public safety. The FAA has begun the process of establishing regulations and guidelines for RLV O&M to accomplish their mission of ensuring public safety. This report extends the top-down analysis documented in RTI's September 2002 report[1] on the same topic. This extension is in the form of supplemental reviews of the Code of Federal Regulations (CFR) for aviation and NASA; a validation activity associated with the Systems Functions and Procedural Items identified in the first report; and initial research and analysis of subsystems and functions associated with RLV O&M activities for the development of Guideline Inputs.

1.1 Purpose

The purpose of this report, and the corresponding documents (RLV O&M Guideline Input Volumes 1-5), is to identify those operations and maintenance requirements that should be universally applied to RLV operators and maintainers to ensure public safety, while at the same time allow for technological development/breakthrough and global competitiveness.

It should be emphasized that each Subsystem and Functional area considered in the course of this research could (and often has been in the past) the subject of a dedicated research effort. The FAA should not consider the results put forward in this report or the accompanying Guideline Input Volumes as comprehensive. Rather this effort has focused on providing a broad overview of the RLV O&M issues that will need to be included in the FAA's RLV O&M Guidelines and subsequent rules.

1.2 Background

The FAA Office of the Associate Administrator for Commercial Space Transportation (AST) produced a draft Rulemaking Project Record (RPR) (information only) paper covering *Licensing and Safety Requirements for Operations and Maintenance of Commercial Reusable Launch Vehicles* in June of 2001.[2] Version 1 of this paper stated that this rulemaking process was to:

- Analyze the Federal Aviation Regulations and determine which are applicable or need to be modified to establish an adequate level of safety for commercial space RLVs O&M.

- Draw upon National Aeronautics and Space Administration (NASA) and Department of Defense (DoD) knowledge and experience to determine appropriate O&M standards and processes for commercial space RLVs from their experiences with the Space Shuttle and RLV Technology Demonstrators like the X-33, X-34, X-37, X-40A, and X-43 programs.

- Utilize the experience of the Commercial Space Transportation Advisory Committee (COMSTAC) RLV Working Group to determine appropriate RLV O&M requirements applicable to individual RLV concepts under development. Specifically, their safety-critical systems will be investigated, many of which are not similar to aviation systems. FAA research may be required to study these systems and concepts, especially if they utilize new materials and techniques.

- Work through the Commercial Space Transportation Integrated Product Team Working Group to ensure that the commercial space RLV O&M draft regulations that are developed have received a thorough review and their approval by the Working Group before becoming a Notice of Proposed Rule Making (NPRM).

- Develop an NPRM utilizing AST Resources and contractor support to determine the commercial space RLV O&M standards and processes necessary to provide an adequate level of public safety during commercial space RLV operations

RTI delivered a report on the topic of RLV O&M in September of 2002 with a subsequent update in December 2002. That report made a series of recommendations on how to proceed, including the identification of a number of System Functions and Procedural Items that warranted detailed research in order to develop associated guidelines to ensure public safety. Procedural Items were renamed to Functions and the Systems Functions became either actual Subsystems or recategorized to Functions. This report continues where the December delivery left off. It provides an overall discussion on how the initial material, developed under Delivery Order 2 (DO2), has been further refined/expanded. More importantly, this report serves as the companion volume to a series of Guideline Input Volumes 1 through 5 (General Considerations, Operations Considerations, Maintenance Considerations, Training Considerations, and Approval Considerations) that are being written in a style to provide direct input to the NPRM and/or Guidelines being developed by the FAA.

1.3 Scope

As noted above, the scope of the overall effort is rather broad as it addresses the entire domain of RLV O&M. This current effort has been constrained primarily to the development of Guideline Input material for the identified Subsystems and Functions represented in Section 2.0. It is expected that resulting Guidelines will be developed by the FAA to supplement the NPRM activity for RLV O&M.

1.4 Research Effort

The general approach used in this research was to conduct a top-down analysis of RLV Subsystems and Functions. The goal of this analysis was two-fold: to identify “what” needs to be specified in any resulting Guidelines/Regulations, and still provide as much flexibility as possible in “how” individual RLV operators and

maintainers perform their work. Since the data collected for use in formulating the RLV O&M Guideline Inputs is associated with specific technologies, or vehicle design, not all Guideline Inputs will apply to all RLV concepts.

Following delivery of the first report associated with this overall effort in September 2002, a set of diagrams was developed to show how the Functions and Subsystems relate to one another. This effort was also intended to validate the DO2 list of Systems Functions and Procedural Items identified in the first report. These diagrams and the process used to develop them are described in the next section of this report.

Additionally, for this phase of the research effort, checklists were developed to focus the data collection activities (see Appendix E Guideline Input Detail Sheets). These checklists were intended to draw out those issues associated with each identified Subsystem and Function that could have a direct bearing on public safety. The data collected using these checklists was then analyzed and parsed to the various Guideline Input Volumes.

This Supplemental Report provides the results of the data capture effort and a description of the synthesis activity used to arrive at the accompanying Guideline Input Volumes. Supporting data, such as the references for each area investigated, is documented in this report.

2.0 Functional Decomposition and Validation

DO2 resulted in the identification of a set of what were then identified as Systems Functions and Procedural Items that are listed below.

Systems Functions

1. Propulsion
2. Communications
3. Navigation
4. Flight Controls
5. Electrical/Wiring
6. Thermal Protection
7. Environmental Systems
8. Surveillance
9. Software
10. Propellant Management
11. Flight Safety System
12. Ground Support Equipment
13. Payload/Cargo
14. Structures
15. Avionics
16. Hydraulics
17. Pneumatics
18. Landing / Recovery Systems
19. Health Monitors & Data Recorders
20. Crew Systems
21. Facilities

Procedural Items

1. Administration
2. Design Approval
3. Production Approval
4. Ground Operations Approval
5. Flight Operations Approval
6. Licensing
7. Launch Approval
8. Continued Flightworthiness
9. Problem Reporting & Tracking
10. Risk Assessment & Management
11. Safety Assurance
12. Mission Assurance
13. Training
14. Inter-& Intra-Agency Coordination

These System Functions and Procedural Items were reexamined for validation in this current effort. Procedural Items were recategorized to Functions and the Systems Functions became either actual Subsystems or renamed to Functions. Subsystems are the hardware and software related systems on the RLV or related to the preparation of an RLV. The Procedural Items were examined, expanded, and organized around a Functional Decomposition Model. The result was a set of Functional Decomposition Diagrams that took the top-down philosophy and expanded the DO2 Procedural Items (Functions). In this new view, Functions are actions or procedures applicable to a given process flow, while Subsystems are hardware and software that are acted upon.

It was determined that a general model was needed to place the Systems Functions and Procedural Items in context with the RLV development and licensing processes. The following Context Diagram, Figure 3 RLV Context Diagram, was developed to provide this contextual framework.

The focus of this research is represented to the right of the vertical line in the Context diagram. A number of the original Procedural Items were identified as being outside the immediate domain of O&M and are therefore denoted to the left of the vertical line. This served to better focus the functional decomposition effort. This context diagram was developed to provide the context for this Functional Decomposition Model, as well as provide a way of marrying the O&M top-down analysis being completed by RTI with the bottom-up analysis being accomplished

internal to the FAA. Functional Guideline Inputs have been developed for those activities associated with operations and maintenance, as well as the related areas of training and approval.

Figure 3 also illustrates how these areas relate to one another and where they fit into the broader scope of RLV licensing, approvals, and RLV development in general. The focus of this effort (the items to the right in of the vertical line) is highlighted in Figure 4.

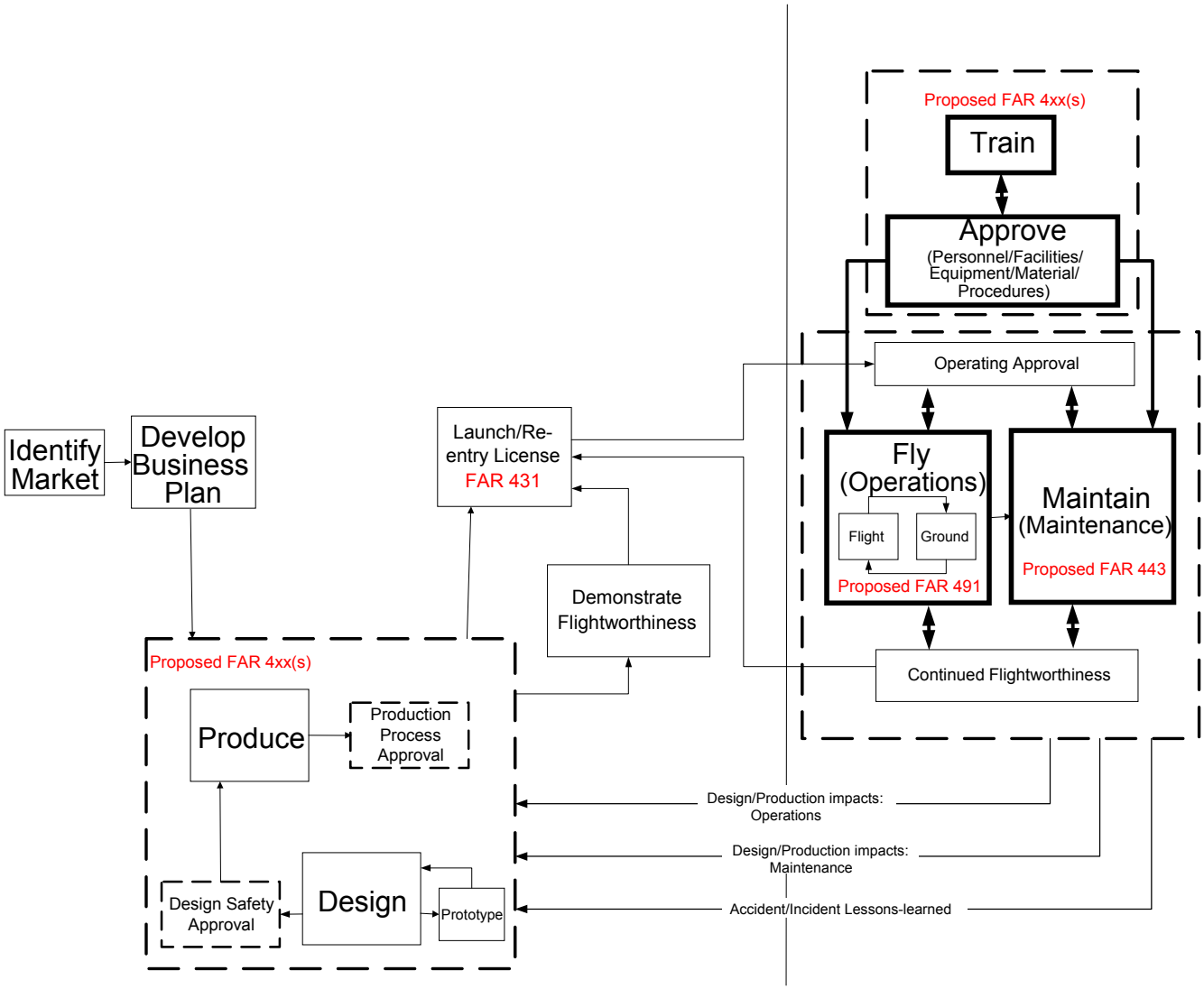

Figure 3 RLV Context Diagram

Each bolded Function in Figure 4 (Operations, Maintenance, Train, and Approval) was expanded into its respective sub-functions. These top-level Functions and associated set of sub-functions are represented in their individual Decomposition Diagram in Sections 2.1, 2.2, 1.1, and 2.4.

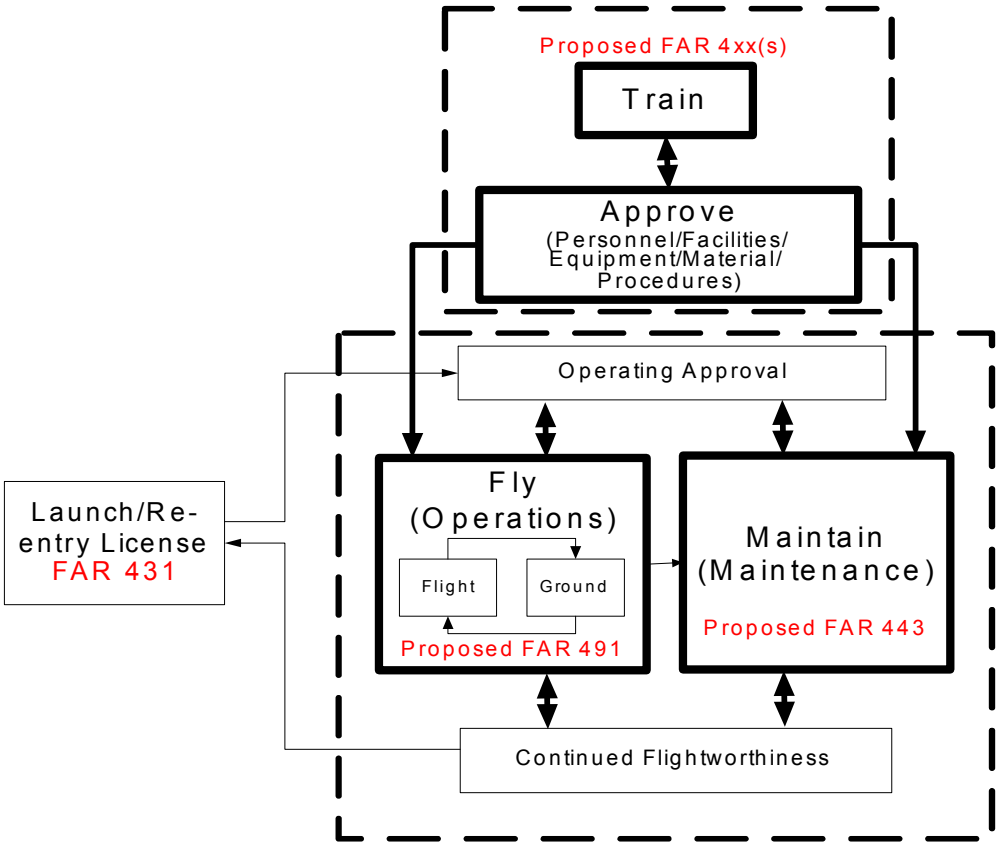

Figure 4 RLV O&M Context

It should also be noted that this top-down analysis is being supplemented by a bottom-up analysis effort being conducted by the FAA. The two efforts taken together are intended to serve as the basis for guidance development in the area of RLV O&M, see Figure 5.

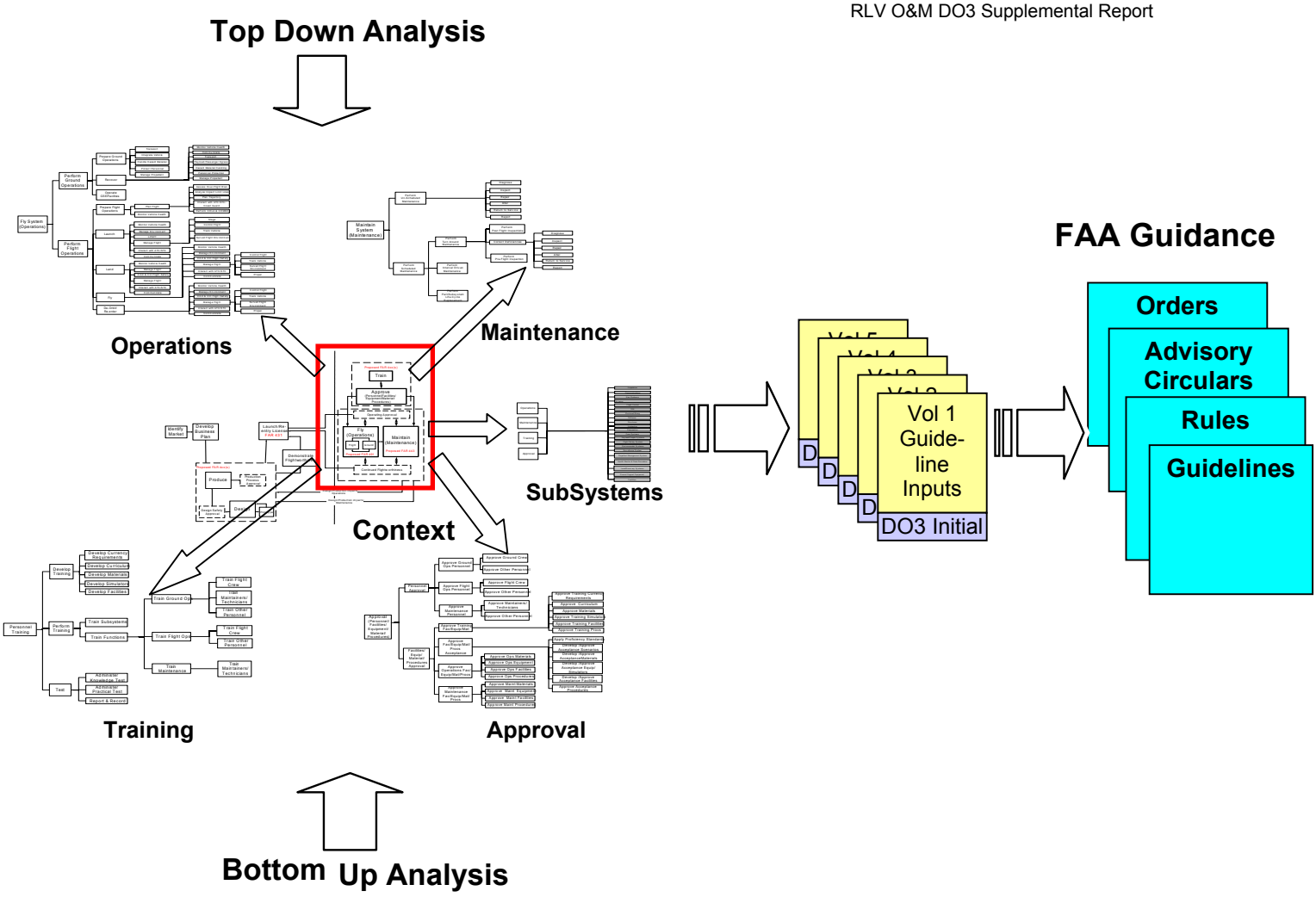

Figure 5 Merger of Top-Down and Bottoms-Up Analysis

The following sections describe each top-level Function (and its major sub-functions) and provide subsystem definitions for each function and sub-function, and provide a brief treatment of the major public-safety considerations for each Function. It should be noted that the Functions depicted and discussed are presented in terms of an action, hence the term function. In contrast, Subsystems actually comprise the RLV or represent equipment that supports the RLV. Subsystems are used in the performance of functions.

2.1 Operations

Figure 6 provides the current functional decomposition for RLV Operations. Operations are divided into Ground Operations and Flight Operations that are subsequently divided into a number of sub-functions. Although this decomposition is performed from a "functional" perspective, the majority of sub-functions relate to one or more specific flight phases (e.g. launch).

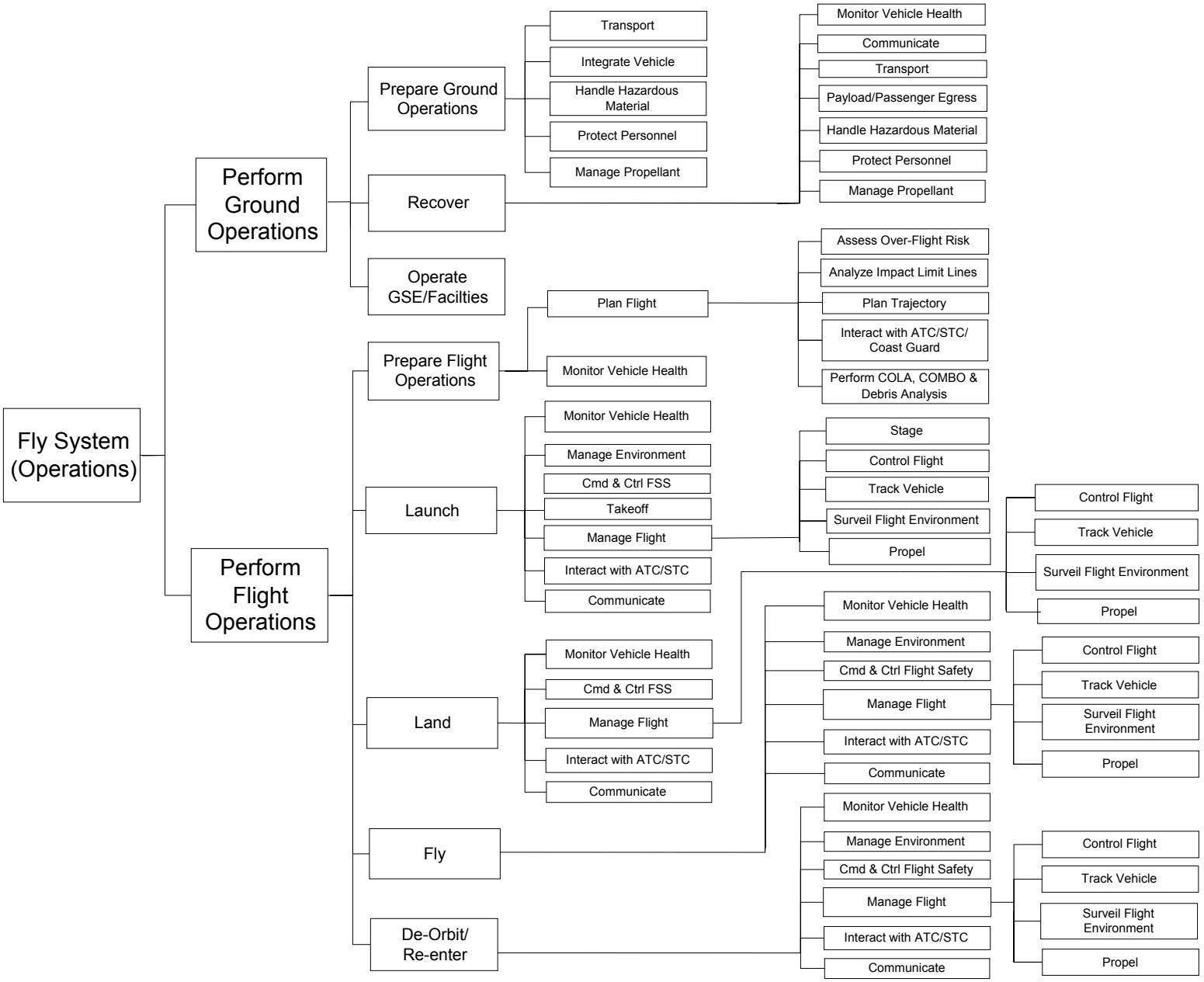

Figure 6 Operations Functional Decomposition

2.2 Maintenance

Figure 7 provides the functional decomposition for RLV Maintenance. Utilizing the maintenance model developed by the Air Transport Association's Maintenance Steering Group, the Maintenance function was decomposed into two major sub-functions: Scheduled Maintenance and Un-scheduled Maintenance. The Scheduled Maintenance function is further divided into three sub-functions: turn-around, interval-driven, and lifecycle replacement.

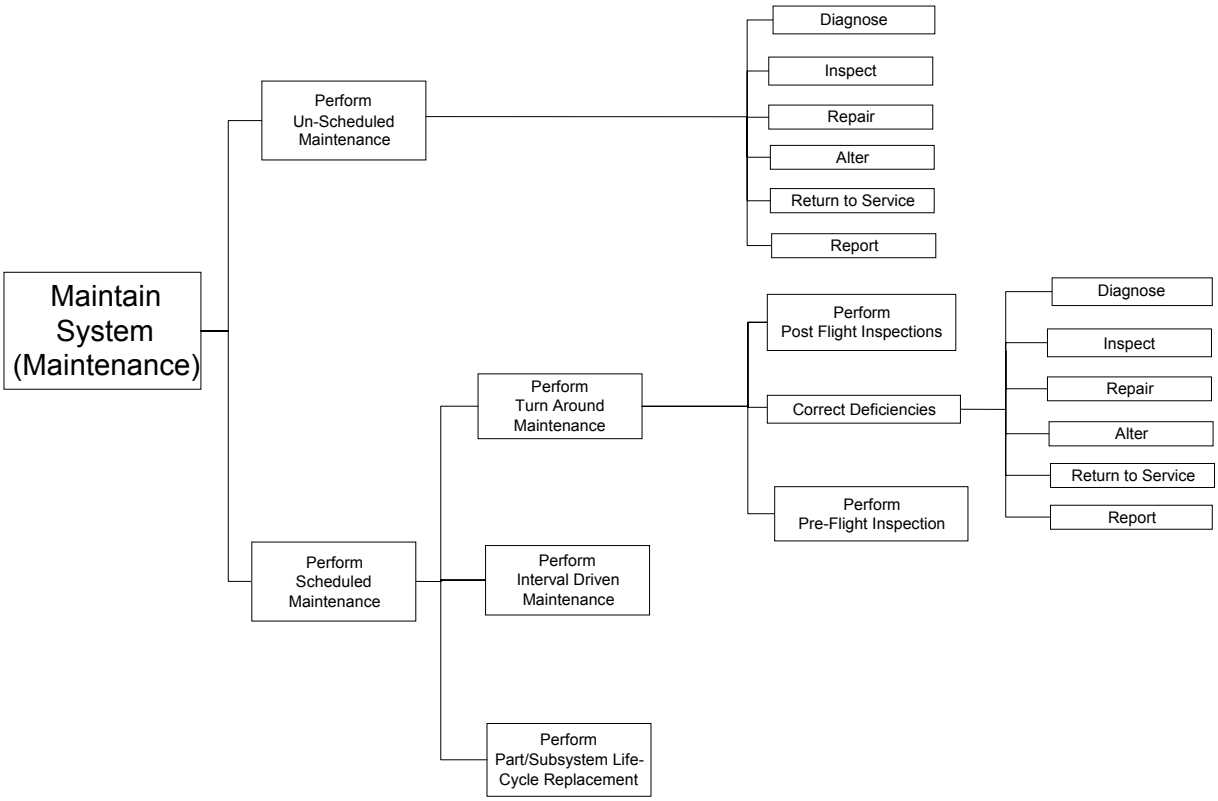

Figure 7 Maintenance Functional Decomposition

2.3 Training

Figure 8 provides the functional decomposition for RLV Training. Training is divided into three major sub-functions: Develop Training, Perform Training, and Test (those trained).

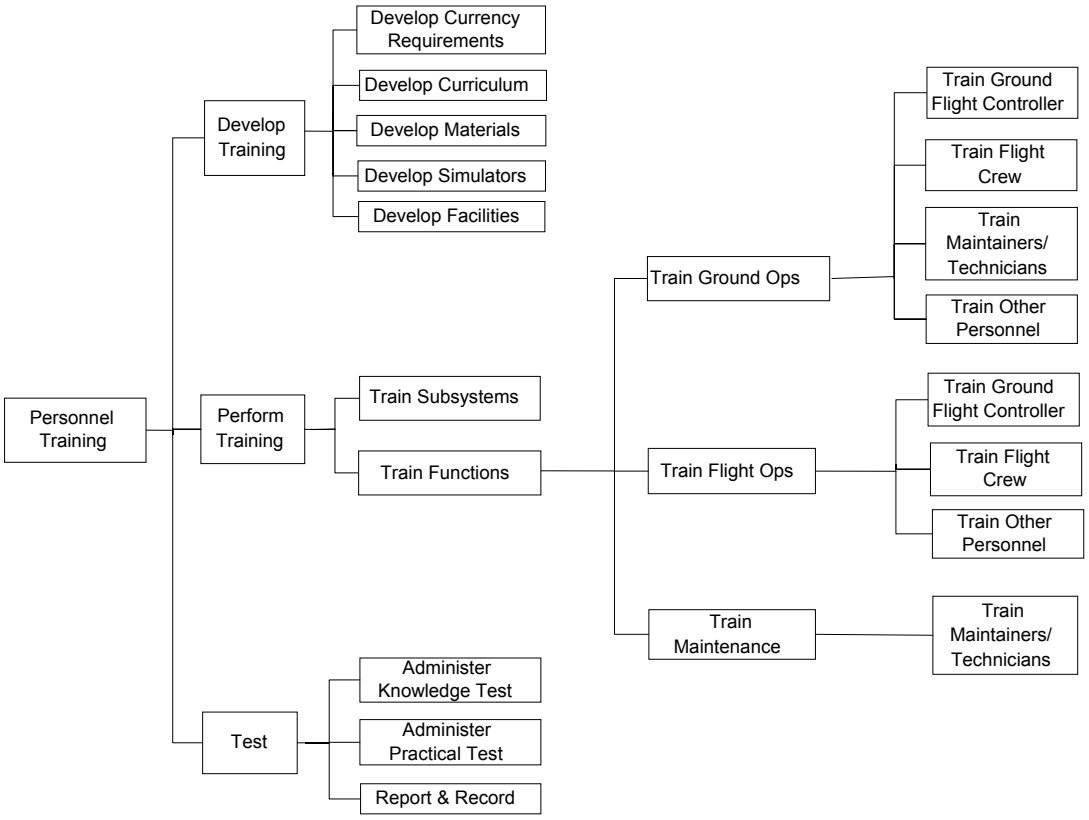

Figure 8 Training Functional Decomposition

2.4 Approval

Figure 9 provides the functional decomposition for RLV Approval activities. For the purposes of these Guideline Inputs, two major facets of the approval process are included. The first covers those activities associated with Personnel Approval in the performance of Ground Operations, Flight Operations, and Maintenance. The second is the approval associated with Facilities, Equipment, Materials, and Procedures that are used in operations, maintenance, training, and acceptance activities. This last activity, acceptance, is for approving facilities, equipment, materials, and procedures that are themselves used to approve other elements including personnel.

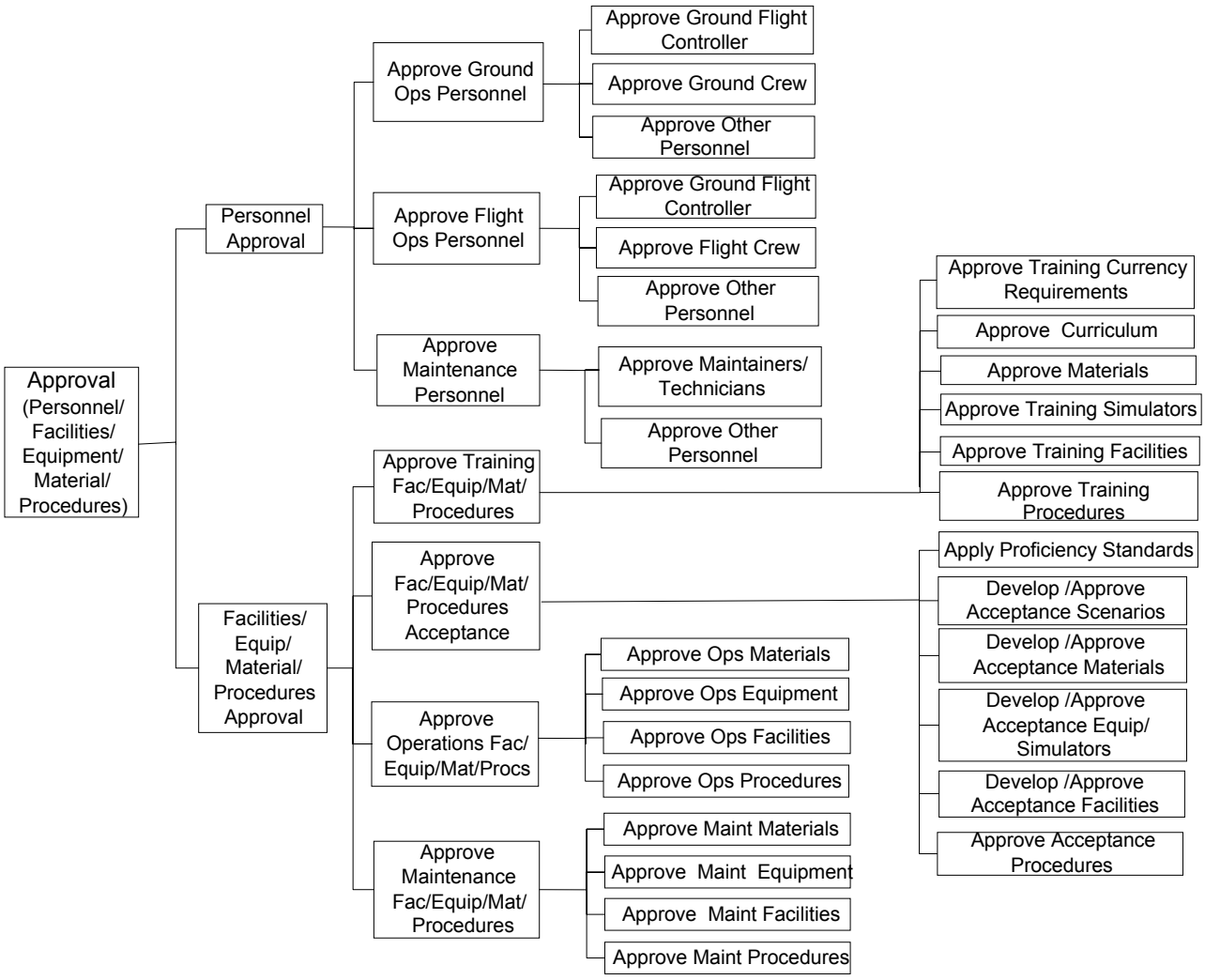

Figure 9 Approval Functional Decomposition

2.5 Subsystem

The Subsystems defined in this document, and the Guideline Input Volumes, are listed on the right side of Figure 10. These Subsystems correlate to the Subsystem Functions that were described in the DO2 report. One minor change from the DO2 list is that the Payload Subsystem Function was renamed the Payload/People Subsystem.

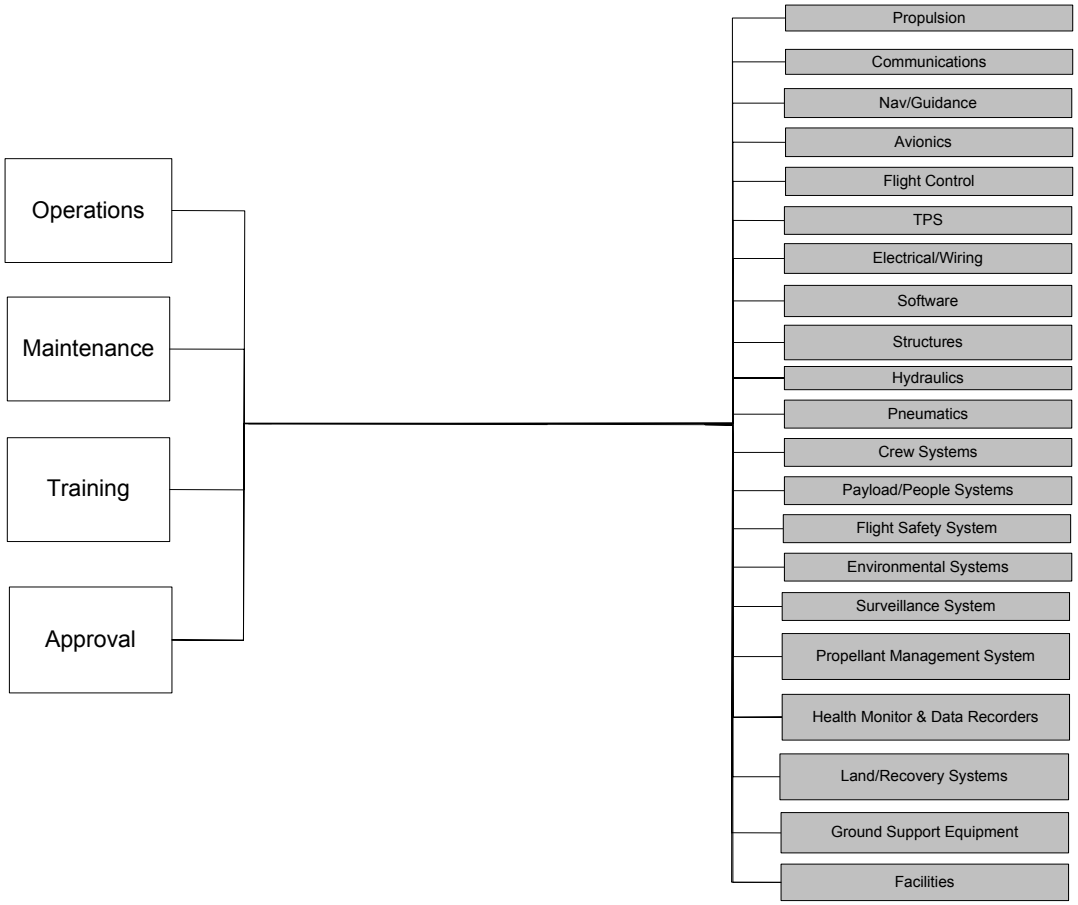

Figure 10 Subsystems

While populating the Subsystem Interaction section of the data collection worksheets (see Appendix E Guideline Input Detail Sheets), it became apparent that the interactions that were being documented might have public safety ramifications during O&M activities. Figure 11 Subsystem Interaction Diagram, graphically depicts the interaction between the various RLV subsystems. Note that the subsystems are divided into two groups: those off-board the RLV and those on-board the RLV. Facilities and Ground Support Equipment are the only subsystems with entirely off-board components. A white box indicates those subsystems that have both on-board and off-board components. For example, the Propellant Management System will have elements on the RLV for management during fueling and flight, but the storage tanks, plumbing, and

fueling management controls are off-board. Subsystems having gray boxes are considered to have only RLV elements.

Colored dashed lines and black solid lines represent the Subsystem interactions. The dashed lines depict the “one-to-many” interactions (e.g. the red dashed line from the Electrical/Wiring Subsystem to the many other subsystems that it interacts with). The black solid lines represent “one-to-one” subsystem interactions. These one-to-one interactions may be uni-directional or bi-directional.

Although subsystem interactions will vary based on the individual RLV design and operational concept, this diagram highlights the need to understand RLV subsystem interdependencies (e.g. Software to Flight Safety System) in order to ensure public safety during RLV O&M activities.

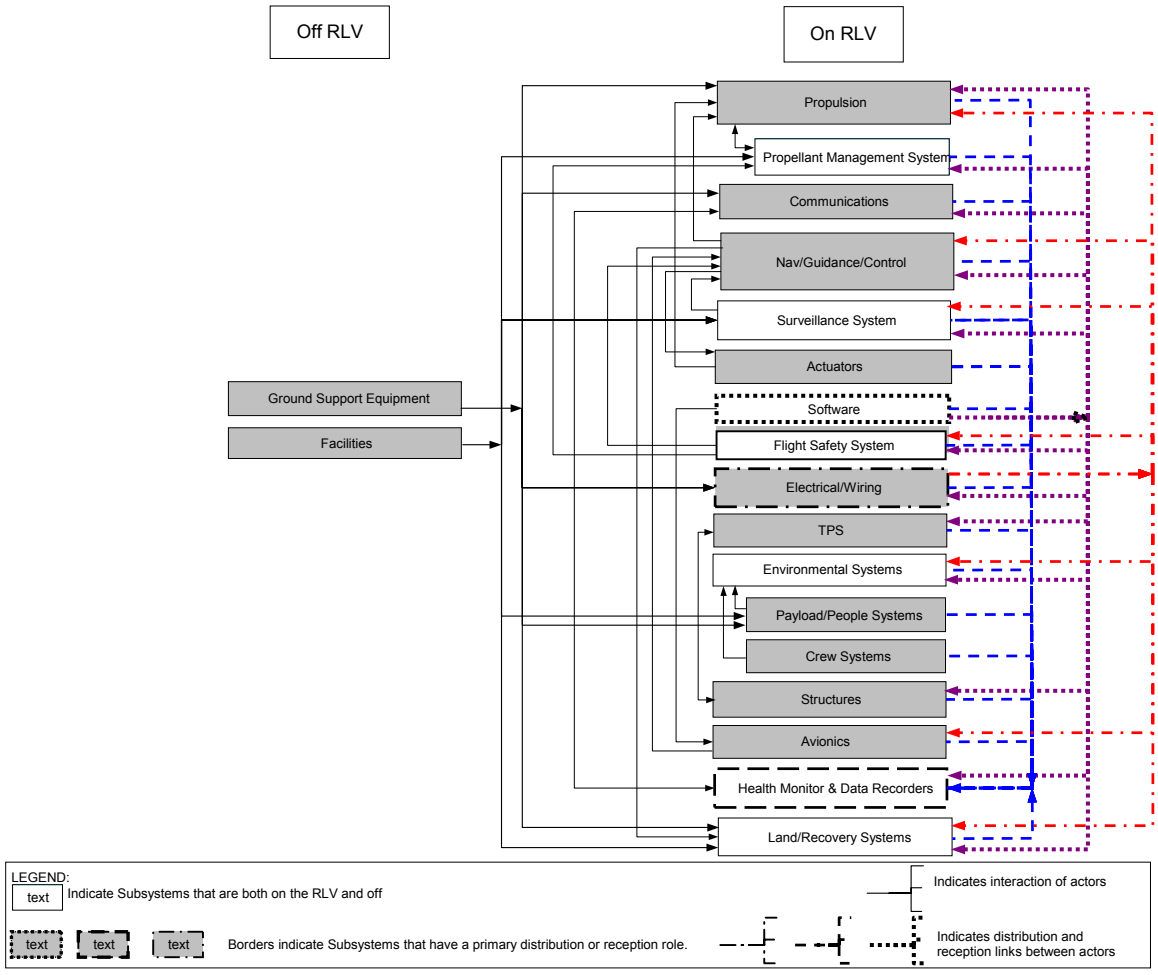

Figure 11 Subsystem Interaction Diagram

3.0 Data Collection

3.1 Supplemental Data

3.1.1 Aviation Domain

3.1.1.1 CFR Reviews

Review of Title 14 – AERONAUTICS AND SPACE of the CFR (Code of Federal Regulations) for their applicability to the RLV O&M domain is an on-going activity under this task. Table 1 identifies the parts of 14 CFR that have been identified for review. During this second phase of the RLV O&M research effort, RTI continued the 14 CFR review activity begun during DO2. Twenty-two parts (rules) had been identified for review by the end of this phase. Of these, six were previously reviewed and are shown in bold in the second column of Table 1. No further review activity was accomplished on these six rules; however, the results of their review were incorporated in the Guideline Input activity.

Additionally, with FAA concurrence, the review of 14 CFR 25 was postponed because of its present inapplicability. The decision, with FAA concurrence, was made to postpone the review of 14 CFR 25 for this phase since all of the RLVs currently being designed are small vehicles and 14 CFR 25 is applicable only to transport category aircraft. It is envisioned that early RLV license applications will be primarily focused on small sub-orbital, and possibly orbital, vehicles.

The following sections provide a brief description of the rules that were reviewed as part of the Phase 2 Review effort. The detailed reviews, including documentation of the lessons-learned, are recorded in Appendix C 14 CFR Review Results.

Note: Table 1 also highlights rules identified for future reviews. Although the remaining list is long, one should note that parts 200 through 399 are primarily focused on the financial evaluation of air carriers and procedural issues.

Table 1 14 CFR Review Phasing (modified from DO2)

Phase 1 Review	Phase 2 Review (This Report)	Future Reviews
1, 11, 13, 21, 23, 33, 34, 39, 43, 65, 91, 135, 139, 145, 147, 183, 381, 383, 400, 401, 404, 405, 406, 413, 415, 420, 431, 433, 435, 440, 450	**21**, **23**, 25, **33**, **34**, 61, 63, 67, 73, 93, 95, 97, 99, 105, 119, 121, **135**, 139, 142, 185, 187, **193**	14, 15, 16, 17, 25, 27, 29, 31, 35, 36, 45, 47, 49, 71, 77, 101, 103, 125, 129, 133, 136, 137, 141, 150, 151, 152, 155, 156, 157, 158, 161, 169, 170, 171, 189, 198, 200, 201, 203, 204, 205, 206, 207, 208, 211, 212, 213, 214, 215, 216, 217, 218, 221, 222, 223, 232, 234, 240, 241, 243, 247, 248, 249, 250, 252, 253, 254, 255, 256, 257, 258, 271, 272, 291, 292, 293, 294, 296, 297, 298, 300, 302, 303, 305, 313, 314, 323, 325, 330, 372, 374, 374a, 375, 377, 380, 382, 385, 389, 398, 399

3.1.1.1.1 14 CFR 61 – Certification: Pilots, Flight Instructors, and Ground Instructors

14 CFR 61 provides detailed rules for the certification of pilots, flight instructors, and ground instructors. These rules were reviewed to determine which areas should be included in the RLV O&M Guideline Inputs Approval Volume.

3.1.1.1.2 14 CFR 63 – Certification: Flight Crewmembers Other Than Pilots

14 CFR 63 provides detailed rules for the certification of non-pilot crewmembers including navigators and flight engineers. It is likely that new categories or non-flight crewmembers may need to be added for certification. These rules were reviewed to determine which areas should be included in the RLV O&M Guideline Inputs Approval Volume.

3.1.1.1.3 14 CFR 67 – Medical Standards and Certification

14 CFR 67 provides rules for the multiple levels of medical approvals for airmen. There are numerous medical issues beyond those contained in 14 CFR 67 that must be considered for space flight crew approvals. These rules were reviewed to determine which areas should be included in the RLV O&M Guideline Inputs Approval Volume.

3.1.1.1.4 14 CFR 73 – Special Use Airspace

14 CFR 73 provides the top-level description and definitions for the creation of Special Use Airspace (SUA). These rules were reviewed to determine their impact on the RLV O&M Guideline Inputs Operations Volume.

3.1.1.1.5 14 CFR 93 – Special Air Traffic Rules and Airport Traffic Patterns

14 CFR 93 provides a description of special air traffic rules for the CONUS and outlying states and territories. Each of these areas will likely require unique procedures for RLV flight within these areas. Specific RLV O&M issues were not identified in this FAR.

3.1.1.1.6 14 CFR 95 – IFR Altitudes

14 CFR 95 provides IFR definitions for the CONUS and outlying states and territories. RLV flight profiles will have to take the information in this FAR into account as flight plans/paths are developed. These rules were reviewed for their impact on the RLV O&M Guideline Inputs Operations Volume.

3.1.1.1.7 14 CFR 97 – Standard Instrument Approach Procedures

14 CFR 97 provides the definitions and rules governing instrument approach including weather minimums. There are numerous issues with this FAR that impact RLV equipage, as well as operations and maintenance. This rule was reviewed for its impact on these areas.

3.1.1.1.8 14 CFR 99 – Security Control of Air Traffic

14 CFR 34 provides a description and rules for conducting operations in Air Defense Information Zones (ADIZ). It was reviewed for impacts to the RLV O&M Guideline Inputs Operations Volume.

3.1.1.1.9 14 CFR 105 – Parachute Operations

14 CFR 105 provides the detailed rules for all types of parachute operations. This area may be of particular interest to RLVs employing unpowered horizontal landing or that need to deploy drag chutes for deceleration in a vertical landing.

3.1.1.1.10 14 CFR 119 – Certification: Air Carriers and Commercial Operators

14 CFR 119 provides the specific requirements that must be satisfied in order to attain an Operating certificate under either Part 121 or Part 135. There is a significant amount of content in this FAR that may effect all four areas included in this effort: RLV Operations, Maintenance, Training, and Approval.

3.1.1.1.11 14 CFR 121 – Operating Requirement: Domestic, Flag, and Supplemental Operations

14 CFR 121 provides ongoing requirements for operators offering carriage for hire services above a specified number of passengers and a specified weight. From this FAR, it is possible to identify a large number of design and maintenance issues, as well as impacts to operations.

3.1.1.1.12 14 CFR 142 – Training Centers

14 CFR 142 provides the basic rules that govern training facilities design to certify personnel under other parts of the aviation FARs. Criteria outlined in this FAR should be considered when developing the Approval Guidelines.

3.1.1.1.13 14 CFR 185 – Testimony by Employees and Production of Records in Legal Proceedings, and Service of Legal Process and Pleadings

14 CFR 185 is an administrative FAR focused on legal proceedings. In general, the rules captured here would appear to be appropriate for legal proceedings involving AST.

3.1.1.1.14 14 CFR 187 – Fees

14 CFR 187 discusses the fee structure for FAA services outside the customary activities of the Agency. Determination and assignment of any fees for activities associated with RLV O&M approvals is outside the scope of the current research effort.

3.1.1.1.15 14 CFR 193 – Protection of Voluntarily Submitted Data

14 CFR 193 is an administrative FAR associated with the protection of proprietary data submitted to the FAA. In general, the rules captured here would appear to be appropriate for protection of data submitted to AST.

3.1.1.2 General Publications Review

There were no General Publications reviewed during this phase of the research effort.

3.1.1.3 Aviation Lessons-Learned

A small number of lessons-learned were extracted from the FAR reviews conducted during this phase of the research. They are captured below using the same categories and numbering scheme identified in the DO2 report. An additional category covering Training and Approval has been added. There are also additional aviation-related lessons-learned associated with the research performed on individual Subsystems and Functions reflected in the accompanying Guideline Inputs Volumes.

3.1.1.3.1 Design, Maintenance and Operations [AV101-150]:

Equipage required in different categories of airspace is likely to come in conflict with RLV needs and weight restrictions. This should be addressed in the process of moving from dedicated SUAs to integrated airspace. [AV109]

3.1.1.3.2 Training and Approval Issues [AV351 - AV400]

Experience measures should be relevant to the domain for which credit is being sought. [AV351]

The FAA should identify a candidate set of classifications to allow gradation in the guidelines and subsequent rules governing levels of training. [AV352]

3.1.2 Space Domain

3.1.2.1 CFR Reviews

Review of the NASA-related Code of Federal Regulations (Chapter V of Title 14) was completed during this phase of research. Unlike the FARs, the regulations associated with NASA are primarily focused on administrative issues. This reflects the different role of NASA (i.e. a research and development entity) as opposed to FAA (a regulator of commercial activities). The results of this review are captured in Appendix D 14 CFR 1200 – 1299 Review.

3.1.2.2 General Publications Review

Since the original DO2 report was produced, the Commission on the Future of the United States Aerospace Industry released its final report[3]. This report was reviewed during this research phase.

Congress established the Commission on the Future of the United States Aerospace Industry in 2001 under the National Defense Authorization Act (P.L.106-398). The Commission was tasked with studying the future of the U.S. aerospace industry in the global economy, and the aerospace industry's future importance to the US economy and national security. The Honorable Robert W. Walker was chairman of the Commission.

Chapter 3 - Space: Its Special Significance identifies three major issues that have a direct impact on the RLV community. The first is Access to Space. The report suggests integrating the work started under the Space Launch Initiative (SLI) and the National Aerospace Initiative (NAI) to achieve RLV technologies needed to enable the development of revolutionary space systems. The second item is the Space Launch Infrastructure. This issue reflects the need to revitalize the aging infrastructure at Kennedy Space Center (KSC) and Cape Canaveral Air Force Station (CCAFS), potentially through privatization and "municipalization" options. The final space-related item is that of Commercial Space – a Capacity and Demand mismatch. The commission feels that "New regulations and incentives will be necessary to bolster this important market until there is a turnaround in demand".

Chapter 6 - Global Markets, identifies several issues pertinent to RLVs. The first is a call for a level international playing field. The commission contends the playing field is out of balance with respect commercial research and development investment – "our government has increasingly pulled back from the civil aerospace market and left it up to U.S. companies to compete against competitors subsidized by (foreign) governments". Another area out of balance regards regulations and standards- "by harmonizing U.S. and foreign safety certification requirements to ensure the highest level of safety while reducing the burden of meeting multiple requirements in different countries". Chapter 6 also identifies the need for a revamping of export controls and defense procurement policies and highlights the need for global partnerships in the areas of air traffic management and cooperative space activities.

Chapter 7 deals with the issue of long-term growth and financial health of the industry. While not directly related to RLV O&M activities, this area does affect the financial ability of the RLV owner/operator to perform these activities safely.

The Commission's recommendations are summarized as follows[5]:

1. The United States boldly pioneer new frontiers in aerospace technology, commerce, and exploration
2. Transformation of the U.S. air transportation system a national priority
3. The United States create a space imperative
4. The nation adopt a policy that invigorates and sustains the aerospace industrial base

5. The federal government establish a national aerospace policy and promote aerospace by creating a government-wide management structure
6. U.S. and multilateral regulations and policies be reformed to enable the movement of products and capital across international borders on a fully competitive basis and establish a level playing field for U.S. industry in the global marketplace
7. A new business model be designed to promote a healthy and growing U.S. aerospace industry
8. The nation immediately reverse the decline in and promote the growth of a scientifically and technologically trained U.S. aerospace workforce
9. The federal government significantly increase its investment in basic aerospace research in order to enhance U.S. national security, enable breakthrough capabilities, and foster an efficient, secure, and safe aerospace transportation system

3.1.2.3 Space Domain Lessons-Learned

Lessons-learned data associated with individual Subsystems and Functional areas are captured in the accompanying Guideline Inputs Volumes. As previously stated, the lessons-learned from the DO2 report[1] were captured and a numbering scheme was adopted. This scheme has been continued in this report. The Reserved numbers continue from the DO2 report. New lessons-learned are assigned the next sequential number. For instance, Space Shuttle Maintenance and Operations has lessons-learned numbers STS401 through STS500 assigned. Two new lessons-learned were added in this report, STS416 and STS417. This applies to the RLV lessons-learned as well. The two new RLV lessons-learned are RLV316 and RLV317.

3.1.2.3.1 Space Shuttle Lessons-Learned

3.1.2.3.1.1 Maintenance and Operations [STS401 – STS500]

Thermal protection during re-entry is a critical element of any space system intended for recovery after flight. The Columbia disaster highlights the necessity to design and maintain a robust Thermal Protection System (TPS). [STS416]

Design, manufacture, and maintenance of one subsystem may have a direct affect on the integrity of another. For example, problems with the external tank insulation employed in the Shuttle Orbiter, may have directly damaged the TPS aboard the Columbia. [STS417]

3.1.2.3.2 RLV Lessons-Learned

3.1.2.3.2.1 Design and Technology [RLV301-RLV400]

Technical credibility relies mainly on the validity of the mass budget[6]. Technology will drive an RLV's mass margin and thus must be evaluated for operability. [RLV316]

3.2 Operations Data

As noted in the Functional Decomposition and Validation section of this report, the Operations Function was divided into the domains of Ground and Flight Operations and then individual sub-functions within these domains were derived. The results of the CFR reviews, as well as the initial data collected during the DO2 effort, were used as a starting point for deriving these functions. RTI then collected and analyzed several references to further characterize this function. These references may be found in the Reusable Launch Vehicles Operations and Maintenance Guideline Inputs - Volume 2 Operations Considerations. The reader is encouraged to refer to that document for the detailed treatment of the Operations Function.

However, as part of the functional decomposition effort, definitions were developed for basic terms used to describe the functions that were derived. These underlying definitions appear in this report. Table 2 defines the "terms of interest" for each of the major functions/sub-functions related to Operations. Discrete terms are defined first. Then these discrete terms are used to define specific Functions. One should note that Functions are defined in terms of "what" actions are taken rather than "who" is taking the action.

Table 2 Operations Decomposition Terms

Terms Used In Operations Decomposition	Definition
ATC/STC	Air Traffic Control/Space Traffic Control (includes Aerospace Traffic Control Operator (ATCO)).
COLA	Conjunction On Launch Assessment – the analysis that encompasses the comparison of the planned RLV ascent flight path, or trajectory, to known space traffic in orbit. The space traffic data is provided by NORAD (North American Aerospace Defense Command). COLA is mainly used as a collision avoidance measure, rather than for conflict detection and resolution.
COMBO	Computation Of Miss Between Orbits – the analysis that computes the "real-time" separation between vehicles in orbit. Again a collision avoidance activity; however, there have been instances where a conflict has been detected and resolved by the relocation of another spacecraft.
Communicate	Communicate is the function that exchanges data/information between the RLV and operations & maintenance entities. This communication may be autonomous, automated and/or human initiated, and it may be in the form of voice, data, or imagery. It may involve both two-way and one-way data and information transmission and reception using the electromagnetic spectrum. Typically in manned space flight there is both verbal and data communications.
Control Flight	Control flight specifically directs the RLV with particular references to changes in attitude and speed. This function encompasses the commands that are sent to the propulsion or control surface subsystems to either modify or maintain the RLV's current flight profile. These commands may be sent by the On-board Flight Crew or the Ground Flight Controllers.

Terms Used In Operations Decomposition	Definition
Debris Analysis	Debris analysis is the process whereby inert, explosive and other debris resulting from an RLV malfunction, and from any planned jettison of vehicle components, are identified. In addition to the generation of debris lists, each piece of debris has an associated impact/casualty area that is used to determine potential risk to the public as a result of either planned or unplanned debris impact.
De-Orbit/Re-Enter	De-Orbit is the set of sub-functions that are performed to place the RLV on a trajectory taking it out of its nominal orbit for re-entering the Earth's atmosphere. Re-Enter refers to the RLV entering the sensible atmosphere after De-Orbit. The sensible atmosphere is defined as the altitude at which the atmosphere offers measurable resistance to a body passing through it.
Flight Operations	Flight operations as defined here encompass all planning, analysis and performance associated with actual flight of the RLV as opposed to ground operations that involve getting the vehicle flight ready.
Fly	The Fly sub-function is the set of tasks employed during the "on-orbit", or lofted segment of a sub-orbital flight, operations phase associated with what has traditionally been called the "mission". In essence it is the time during which the RLV fulfills its purpose for the flight. The tasks associated with Fly include monitoring the health of the RLV; managing the atmospheric environment on-board the RLV; ensuring safety of flight; managing the flight controls; interacting with air and space traffic management; and communications.
Flight Safety System (FSS)	Current FAA/AST guidance defines FSS as "a system designed to limit or restrict the hazards to public health and safety and the safety of property presented by a launch vehicle or reentry vehicle while in flight by initiating and accomplishing a controlled ending to vehicle flight. A flight safety system may be destructive resulting in intentional break up of a vehicle or nondestructive, such as engine thrust termination enabling vehicle landing or safe abort capability."[7] The FSS can include both non-destructive and destructive methods to "safe" the operation. The non-destruct methods involve commanding the vehicle to a safe configuration (e.g. expelling all hazardous materials prior to landing) The destructive method has traditionally been referred to as the Range Safety System (RSS) or Flight Termination System (FTS). This system typically has two commands (arm and fire) transmitted from the ground station when an errant vehicle poses a threat to public safety. However, this can be done simultaneously as seen in Sea Launch's FTS.
Ground Operations	Ground operations include all activities on the ground associated with getting the RLV ready to fly and recovering the vehicle/cargo post flight.
Hazardous Material	The Eastern and Western Range 127-1[8] defines hazardous materials as those liquids, gases, or solids that may be toxic, reactive, or flammable or that may cause oxygen deficiency either by themselves or in combination with other materials.

Terms Used In Operations Decomposition	Definition
Impact Limit Lines	Impact Limit Lines (ILLs) are established to define the launch and downrange areas to be protected. Significant debris pieces that could cause property damage and personal injury from malfunctioning launch vehicles must be contained inside the ILLs.
Integrate Vehicle	Integrate vehicle involves all activities associated with the integration of RLV flight elements (e.g. orbit vehicle to boost stage), and the integration of the RLV to its cargo (payload and/or passengers. For the purposes of this effort, vehicle integration does not include any passenger servicing activities such as those conducted in commercial aviation.
Interact with ATC/STC/Coast Guard	During RLV operations it will be necessary to coordinate with multiple agencies: with ATC (Air Traffic Control) authorities to ensure airspace reservation and Notification To Aviators (NOTAMs) of potential in-flight hazards associated with the launch/landing of the RLV; with STC (Space Traffic Control) authorities for on-orbit allocation; and with the Coast Guard for Notification To Mariners (NOTMARs) of potential over flight hazards during launch/landing. This function will evolve based on the particular concept of operations (CONOPS) the FAA finalizes and the operator's CONOPS. Interaction with ATC and STC will change over time based on the implementation of the integration of RLVs into the NAS as mentioned in the DO2 report.[9]
Land	The Land Function is the set of sub-functions employed during the "landing" phase of RLV operations. Land is the function of controlling the RLV to the final approach at the landing site through the start of the recover operation. These operations include monitoring the health of the RLV; managing the atmospheric environment on-board the RLV; ensuring safety of flight; managing the flight controls; interacting with air and space traffic management; and communicating voice and data.
Launch	The Launch Function is the set of RLV flight operations from when a launch vehicle arrives at a US launch site leading up to and including take-off through orbit insertion. Launch operations include launch commit, count-down, monitoring the health of the RLV; managing the atmospheric environment on-board the RLV; staging; ensuring safety of flight; managing the flight controls; interacting with air and space traffic management; communicating voice and data; and flight of the vehicle to the height of its suborbital trajectory or to orbit insertion.
Manage Environment	Manage Environment manages procedures and equipment functionality with all aspects associated with the RLV personnel and equipment environment including: atmospheric conditions (e.g. temperature, humidity, contamination, …) on-board the RLV, safety [Quantity-Distance (Q-D) explosive separation], RLV personnel and payload security and traffic proximity to the RLV and its associated equipment.
Manage Flight	Involves all aspects surrounding the actual flight environment: tracking the vehicle, surveiling the flight environment, controlling the flight and commanding the vehicle.
Manage Propellant	Propellant management includes all aspects of coping with propellant in a safe and efficient manner during ground operations.

Terms Used In Operations Decomposition	Definition
Monitor Vehicle Health	Monitoring vehicle health is a means of verifying the operational status of all critical systems and hardware associated with vehicle assembly, launch, and support operations. This includes: detection of functional failures and degraded component performance; assessing the impact of a failure on current launch schedules; and identification of maintenance actions required prior to flight.
Operate GSE/Facilities	GSE (Ground Support Equipment) is that equipment on the ground, including all tools and devices (mobile or fixed) that are required to inspect, test, adjust, calibrate, repair, assemble, disassemble, transport, and service the RLV. Operation of the facilities would include environmental control of facilities, security and safety functions.
Over-Flight Risk	Risk associated with the flight of an RLV over populated areas. The calculation of the risk includes determining the E_C (casualty expectation) associated with both planned and unplanned debris impacts.
Payload/Passenger Egress	Off loading of payload and passengers during the recovery operation.
Plan Flight	Includes the assessment of risk, the definition of impact limit lines, optimization of the RLV trajectory/flight plan, and communiqués with external agencies.
Plan Trajectory	Planning the trajectory involves identifying the optimum trajectory to accomplish the mission of the flight within safety constraints.
Propel	To propel is to impart motion to the RLV via the propulsion subsystem.
Protect Personnel	Includes structures and material handling equipment, personnel protection equipment (e.g. goggles, ear protectors, Self-Contained Atmospheric Protective Ensemble (SCAPE) suits), and standards/procedures designed to mitigate risk during ground operations.
Recovery Operation	Includes those functions, tasks, and procedures required to recover the RLV and/or any of its flight elements (e.g. SRM) after landing, for subsequent turnaround servicing, assembly and integration[10]
Stage	A stage is defined as a self-propelled, separable element of the RLV. “To stage” a vehicle is defined as the shedding of no-longer-required structural mass (e.g. empty tanks).
Surveil Flight Environment	Surveil means to subject to surveillance and it is the systematic observation of the airspace by visual, aural, electronic, photographic or other means. It includes the detection, tracking, characterization, and observation of aircraft, other vehicles, people and weather phenomena for the purpose of conducting flight operations in a safe and efficient manner.
Take-off	Take-off is defined as that point at which the RLV experiences first motion from its launch point. Note: take-off is applicable to ascent from any angle whereas lift-off is applicable only to a vertical ascent.
Track Vehicle	This is the process of monitoring the movements of the RLV and may be done using an optical, radar, or GPS system. Tracking data is used to compare actual and nominal flight trajectories, verify performance in conjunction with telemetry, and identify violations of destruct lines.
Transport	Transport is defined as the movement of the RLV, or one of its flight elements, when not in flight. It may be multi-modal (i.e. land, sea or air), or it may be accomplished using the propulsion system of the RLV itself.

3.3 Maintenance

As noted in the Functional Decomposition and Validation section of this report, the Maintenance Function was divided into two major functions: Scheduled and Un-scheduled Maintenance (Re: the aviation model established by the Air Transport Association Maintenance Steering Group). Then individual sub-functions within Scheduled and Un-scheduled Maintenance were derived. The results of the CFR reviews, particularly FAR 43, as well as the initial data collected during the DO2 effort, were used as a starting point for deriving these functions. RTI then collected and analyzed several references to further characterize RLV maintenance functions. These references may be found in the Reusable Launch Vehicles Operations and Maintenance Guideline Inputs - Volume 3 Maintenance Considerations. The reader is encouraged to refer to that document for the detailed treatment of the Maintenance Function.

However, as part of the functional decomposition effort, definitions were developed for basic terms used to describe the functions that were derived. These underlying definitions appear in this report. Table 3 defines the "terms of interest" for each of the major functions/sub-functions related to Maintenance. Individual terms are defined first, and are then combined to actually arrive at aggregate definitions (i.e. function names). One should note that Functions are defined in terms of "what" actions are taken rather than "who" is taking the action.

Table 3 Maintenance Decomposition Terms

Terms Used In Maintenance Decomposition	Definition
	Note: Maintenance consists of preventive/interval-driven maintenance, vehicle modification, and vehicle repair activities.
Alter	To change, make different, or modify from the original design.
Correct Deficiencies	To correct problems in the implementation of the design.
Diagnose	Diagnose is the set of sub-functions that are used to analyze the cause or nature of a problem. This may include formulation of actions or procedures required to repair or replace and the time and resources required to perform the action.
Inspect	To check, test or compare a system, subsystem, component or part against established standards of operation, wear criteria (such as worn parts), damage, and deviations from design.
Interval Driven Maintenance	Preventive maintenance of a part/subsystem based on a previously defined time period or metric (e.g. flight hours) to ensure reliable and continued safe operation of the RLV.
Part/Subsystem Life-Cycle Replacement	The replacement of parts based on the amount of time that a given part or subsystem is expected to perform within design tolerances.

Terms Used In Maintenance Decomposition	Definition
Post Flight Inspections	A set of checks/tests designed to identify any unexpected problems or maintenance/repair items due to incidents during flight or due to exposure to conditions such as space environment, vibrations, high speed etc.
Pre-Flight Inspection	A set of checks/tests designed to verify flight readiness of the vehicle, to include closeout of problems identified in the previous flight/post-flight inspection. This may also include checking if all of the equipment from a minimum equipment list (required safety equipment) are operational.
Repair	To restore to continued flightworthiness operating state by replacing or fixing a system, subsystem, component or part.
Report	To make a record or summary of a maintenance activity to be used for further improvements to the process as well as to track if the maintenance process itself caused further problems.
Return to Service	This is the formal turnover from maintenance to operations – declared flight worthy by maintenance.
Scheduled Maintenance	The set of sub-functions that utilize a scheduled downtime of the vehicle to allow performance of turnaround maintenance; interval driven maintenance item(s); and system, subsystem, component, or part life cycle replacement.
Turnaround Maintenance	The set of maintenance sub-functions to be performed that return the vehicle to flightworthiness status and are performed every flight. This maintenance may be limited to checking and fixing the equipment that are sensitive to space conditions, and/or are highly safety-related.
Un-Scheduled Maintenance	Maintenance which is performed in response to a problem encountered/discovered during flight operations, or ground operations, or scheduled maintenance or pre- or post- flight inspection.

3.4 Training Data

Data collection for the Training Function was organized around its three constituent functions: Develop, Delivery, and Testing, which were identified in the Functional Decomposition and Validation section of this report. The results of the CFR reviews, particularly FARs 65 and 145, as well as the initial data collected as part of the DO2 effort were used as a starting point for deriving the functions associated with training. It should be noted that there is some overlap between the Testing and Approval functions. Additional references were also collected and analyzed to further characterize the Training Function. These references may be found in the Reusable Launch Vehicles Operations and Maintenance Guideline Inputs - Volume 4 Training Considerations. Although Training is upstream from direct O&M activities, it is still possible to postulate a set of major safety issues for each training function. The reader is encouraged to refer to Volume 4 for the detailed treatment of the Training Function.

However, as part of the functional decomposition effort, definitions were developed for basic terms used to describe the functions that were derived. These underlying definitions appear in Table 4 Training Decomposition Terms. Individual terms are defined first, and are then combined to actually arrive at aggregate definitions (i.e. function names). One should note that Functions are defined in terms of “what“ actions are taken rather than “who” is taking the action.

Table 4 Training Decomposition Terms

Terms Used In Training Decomposition	Definition
	Note: there are four basic types of training under discussion: 1. Initial training (for initial approval) 2. Recurrent Training (to maintain proficiency and required at a specified time interval) 3. Supplemental Training (due to change in configuration, technology, tools, techniques or regulation) 4. Remedial Training (due to need for rebuilding proficiency)
Currency Requirements	This relates to recurrent training, its motivation is to maintain proficiency and is required at a specified time interval. (e.g. recurrent ground and flight training for a particular airplane and crewmember position is required every 12 months by the FAA)

Terms Used In Training Decomposition	Definition
Curriculum	Curriculum, in this context, is defined as the set of courses that will be used to train Ground Flight Controllers, pilots/crew, maintainers/technicians/inspectors, and other personnel as appropriate based on the RLV concept of operations. There are two types of curriculum defined by the FAA in 14 CFR –Chapter I- Part 142: *Core Curriculum* - consists of training in basic subjects important for that job; for example, all maintainers will learn how to use a basic set of tools. It does not include specialized training for tasks related to a specific rating, for example, maintenance training for a specific type of propulsion. *Specialty Curriculum* means a set of courses that is designed to address training requirements unique for specific type of an RLV or a specific type of subsystem. For example, Flight Crew training for a HTHL may be very different from that for VTVL.
Facilities (for training)	Facility means the physical environment required for training and qualification (e.g. buildings, classrooms). These facilities will house the flight training equipment and courseware, including flight simulators or other advanced flight training devices.
Flight Crew	Personnel in charge of and at the flight controls of an RLV are referred to as the Flight Crew in this document. Each RLV is different in its flight profile and vehicle characteristics. There may also be un-piloted vehicles in the future with a flight crew on the ground. These Ground Flight Controllers are considered part of the Flight Crew. Some RLVs may have flight crew on-board only. Yet others may have a crew that is on-board and a crew that is on the ground. Flight crew have two types of responsibilities; one while on ground to move the vehicle to aid ground operations and while in flight, fly the vehicle according to flight operations directions.
Flight Ops	Includes all elements pertaining to vehicle flight from mission planning, analysis and preflight coordination activities to in-flight activities (i.e. launch-fly-deorbit/reenter-land).
Ground Flight Controller	Personnel on the ground who are trained and approved to perform required RLV flight operation functions for either crewed or uncrewed RLVs.
Ground Ops	Ground operations include all vehicle preparation and movement prior to take-off/launch and all post-flight activity following touch-down. Additionally this function involves the operation of ground support equipment and facilities. Ground ops also include replenishing of consumables such as propellants in preparation for the flight.
Knowledge Test	Written or oral test used to assess the level of domain knowledge.
Maintainers/Technicians	Those personnel who perform maintenance, repair and servicing of the RLV during ground operations using appropriate GSE/facilities.
Maintenance	Consists of preventive/interval-driven maintenance, vehicle modification and vehicle repair activities.

Terms Used In Training Decomposition	Definition
Materials (for training)	Materials necessary to instruct/train (e.g. visual aids, classroom instructions, references, records, reports, tests and examinations).
Other Personnel	Based on the RLV CONOPS, other personnel may require training in ground or flight operations of a particular vehicle (e.g. an STC - Space Traffic Controller). Trainers and approval personnel should also be trained.
Practical Test	Test used to demonstrate that one has acquired a particular skill. Practical tests contain specific tasks in which competency must be demonstrated through hands-on performance by the applicant before being approved.
Report & Record	These documents record the results of the training and will most likely include the following information: The name of the trainee; copy of the trainee's certificate, if any; the name of the course; and the make and model of the training equipment used; the trainee's prerequisite experience and course time completed; the trainee's performance on each lesson and the name of the instructor providing instruction; the date and result of each end-of-course practical test and the name of the evaluator conducting the test; and the number of hours of additional training that was accomplished after any unsatisfactory practical test.
Simulators	Simulation[11] is defined as modeling of systems and their operations using various means of representation. Simulation may also be referred to as a model, tool, simulation model or a toolset. Simulators are likely to be used in training of personnel performing operations and maintenance.

3.5 Approval Data

Data collection for the Approval Function was organized around two major facets of the approval process: those activities associated with Personnel Approval and those associated with the approval of Facilities, Equipment, Materials, and Procedures that are used in operations, maintenance, training, and acceptance activities. The results of the CFR reviews as well as the initial data collected as part of the DO2 effort were used as a starting point for this functional decomposition effort. Additional references were also collected and analyzed to further characterize the Approval Function. These references may be found in the Reusable Launch Vehicles Operations and Maintenance Guideline Inputs - Volume 5 Approval Considerations. It should be noted that a jurisdictional question has been raised regarding the FAA's need for oversight of facilities. The data collection effort has been kept broad to include this area because RTI believes strongly that there are public safety implications associated with the facilities used to operate and maintain RLVs. The reader is encouraged to refer to Volume 5 for the detailed treatment of the Approval Function.

The underlying definitions for the Approval Function decomposition are captured in Table 5 below. Individual terms are defined first, and are then combined into aggregate definitions (i.e. function names). One should note that Functions are defined in terms of "what" actions are taken rather than "who" is taking the action.

It should also be mentioned that there is some overlap between the Approval Function and the Test sub-function of Training. Similarly, there is overlap between Approval, as it is used here, and the design and production approval activity. Since both of these areas are outside the current scope of this effort, RTI has tried to restrict the consideration of Approval to only those issues with a direct O&M impact.

Table 5 Approval Decomposition Terms

Terms Used In Approval Decomposition	Definition
	Note: Approval as used here is the formal FAA approval required to perform a given function
Acceptance Procedures	Rules that are followed by approval personnel in order to accept/approve procedures that are used in operations, maintenance, training, and approval.
Acceptance Scenarios	Scenarios of job situations (such as a flight crew training for compensating a stall situation) that must be included in the training. These scenarios are specific for ground operations, flight operations, maintenance, training, and approval.
Currency Requirements	This relates to recurrent training. The intent is to maintain proficiency and is required at a specified time interval. (e.g. recurrent ground and flight training for a particular airplane and crewmember position is required every 12 months by the FAA)

Terms Used In Approval Decomposition	Definition
Curriculum	Set of courses that will be used to train ground flight controllers, pilots/crew, maintainers/technicians, and other personnel as appropriate based on the RLV concept of operations. There are two types of curriculum defined by the FAA in 14 CFR –Chapter I- Part 142: *Core Curriculum* - consists of training, which is required for certification. It does not include training for tasks and circumstances unique to a particular user. *Specialty Curriculum* means a set of courses that is designed to satisfy a requirement of the Federal Aviation Regulations that includes training requirements unique to one or more training center clients.
Facilities and Equipment	Facilities and equipment are defined as those associated with an RLV program namely processing and mission control. Processing equipment and facilities include those used for training, repair/test, ground processing (e.g. replenishment of consumables), and fabrication (making of replacement parts). Mission control facilities are the tools and facilities directly supporting the RLV mission - these include ground control facilities for surface movement(i.e. traffic control in and around the terminal area, coordination of schedule, sequencing for departure and arrival, simulators, display consoles) and flight control facilities (traffic coordination and control handoffs to other controllers in other national and international sectors, coordination of alternate space ports in case of emergencies, coordination of military traffic, SUA,s and NOTAMs).
Flight Crew	The person in charge of and is at the flight controls of an RLV is referred to as the Flight Crew in this document. Each RLV is different in its flight profile and vehicle characteristics. There may also be un-piloted vehicles in the future with a flight crew on the ground. These personnel are called Ground Flight Controllers. Some RLVs may have flight crew on-board only. Yet others may have a shared flight crew, some personnel on-board and some on the ground performing different activities at different points in the vehicle's flight.
Flight Ops Personnel	Personnel performing Flight Ops; Flight Operations Include all elements pertaining to vehicle flight from mission planning, analysis and preflight coordination activities to in-flight activities (i.e. launch-fly-de-orbit/reenter-land).
Ground Crew	Ground crew includes Flight Crew personnel and Maintainers/Technicians who support Ground Operations.
Ground Flight Controller	Personnel on the ground who are trained and approved to perform required RLV flight operation functions for either crewed or uncrewed RLVs.
Ground Ops Personnel	Personnel performing Ground Ops; Ground operations include all vehicle preparation and movement prior to take-off/launch and all post-flight activity following touch-down. Additionally this function involves the operation of ground support equipment and facilities. Ground ops also include replenishing of consumables such as propellants in preparation for the flight.
Maintainers/Technicians	Those personnel who perform maintenance, repair and servicing of the RLV and its payload during ground operations using appropriate GSE/facilities.

Terms Used In Approval Decomposition	Definition
Materials	Materials are defined as items used in training, operations, maintenance and approval such as class instructions, references, records, reports, tests and examinations. These materials may be specific to an RLV and specific to job functions such as Ground Flight Controller, Flight Crew, Maintainers/technicians and other personnel. Other personnel may include Trainers and Approval Personnel. These materials are also expected to be specific to initial training, supplemental training, retraining and remedial training. For example supplemental training may be limited only to new tools, technology or technique. Retraining may be based on the frequency of usage of certain tools and techniques. Remedial training may be individualized. Materials used for these purposes would be tailored to the type of training.
Other Personnel (Flight Ops)	Personnel other than Ground Flight Controller and Flight Crew. These may include Trainers and Approval personnel.
Other Personnel (Ground Ops)	Personnel other than Ground Flight Controller and Ground Crew. These may include Trainers and Approval personnel.
Other Personnel (Maintenance)	Personnel other than Maintainers/Technicians/Inspectors. These may include Trainers and Approval personnel.
Procedures	Procedures in this context are the procedures used for training, operations, maintenance and approval. (These procedures are connected to the operational readiness review and maintenance readiness review that was proposed for submittal at the time of licensing.)
Proficiency Standards	Proficiency standards are the required level of domain knowledge, competency, and skill set to perform the job. Proficiency standards are specific to a given job/set of duties.
Simulators	Simulation[11] is defined as modeling of systems and their operations using various means of representation. Simulator is defined as a model, tool, simulation model or a toolset. Simulators are likely to be used in training of personnel performing operations, maintenance, and approval

3.6 Subsystems

Data collection was completed for each of the Subsystems. Where available, specific standards and guidance developed by the aviation or space communities have been identified. It should be noted that many of the references date back to the 1980's when a considerable amount of research was being done in support of the Shuttle program. Likewise, many of the more current references come from Europe where a significant amount of research and development is currently being conducted under the auspices of the European Space Agency (ESA).

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3.6.20 Facilities

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4.0 Data Synthesis

Data synthesis for this effort is represented by the decomposition of the Functions (discussed in Section 2.0 above) and in the supporting Guideline Input Volumes 1-5. The data has been packaged into a series of Guideline Inputs Volumes to facilitate work being done internal to the FAA to arrive at the first set of RLV O&M guidelines. Figure 12 shows the breakout of these volumes. Definitions and a general treatment of the public safety issues for the Subsystems and Functions identified in this report are also included in Volumes 1-5.

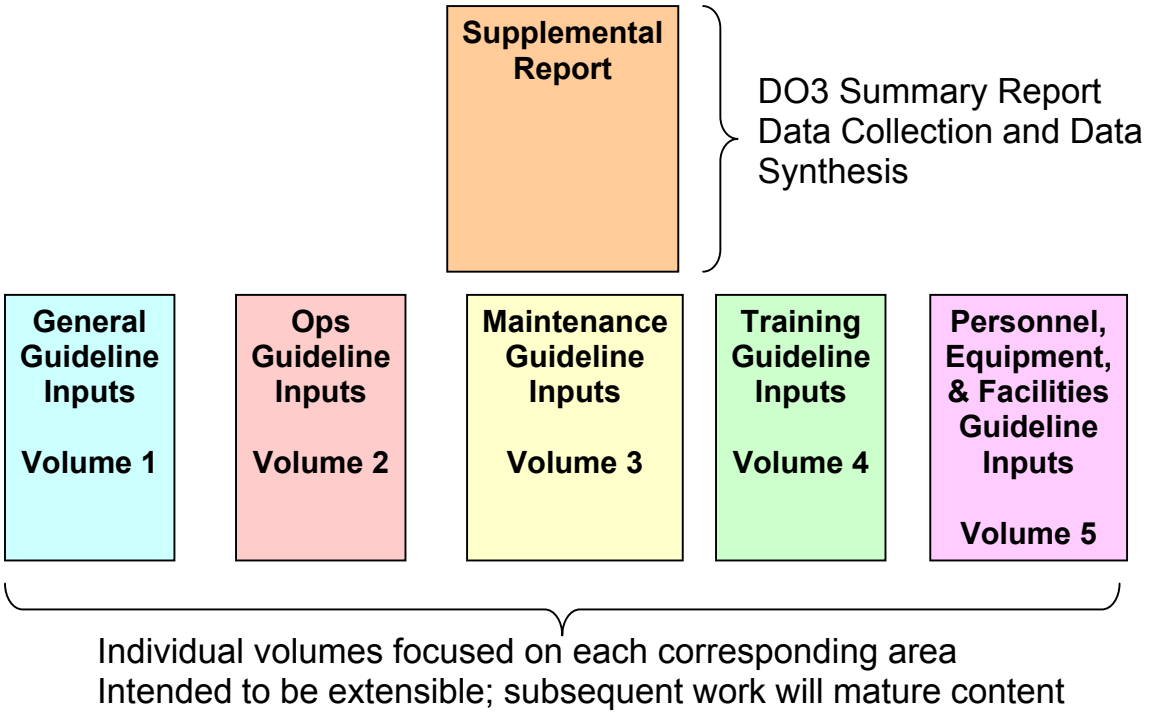

Figure 12 DO3 Document Breakout

4.1 General

Data synthesis for Subsystems is included in Volume 1, General Considerations, of the Guideline Inputs that accompanies this report. The first release of this volume also provides a specific list of major safety issues for each subsystem. Subsequent releases of this volume will build on the safety issues by identifying specific draft guidelines and supporting rationale.

4.2 Operations

Data synthesis associated with the Operations Function is included in Volume 2 of the Guideline Inputs accompanying this report. The first release of this volume also provides a specific list of major safety issues for each operations sub-

function. Subsequent releases of this volume will build on the safety issues by identifying specific draft guidelines and supporting rationale.

4.3 Maintenance

Data synthesis associated with the Maintenance Function is included in Volume 3 of the Guideline Inputs accompanying this report. The first release of this volume contains the framework, definitions, and a brief treatment of major safety issues for each maintenance sub-function. Subsequent releases of this volume will extend this work by identifying specific guidelines and supporting rationale.

4.4 Training

Data synthesis associated with the Training Function is included in Volume 4 of the Guideline Inputs accompanying this report. The first release of this volume contains the framework, definitions, and a brief treatment of major safety issues for each training sub-function. Subsequent releases of this volume will extend this work by identifying specific guidelines and supporting rationale.

4.5 Approval

Data synthesis associated with the Approval Function is included in Volume 5 of the Guideline Inputs accompanying this report. The first release of this volume contains the framework, definitions, and a brief treatment of major safety issues for each approval sub-function. Subsequent releases of this volume will extend this work by identifying specific guidelines and supporting rationale.

4.6 Subsystems

Data synthesis for Subsystems is included in Volume 1, General Considerations, of the Guideline Inputs that accompanies this report.

4.7 Other Topics

4.7.1 Common Issues

In the course of completing the DO2 effort, a number of common issues that affect O&M were identified. In accomplishing the DO3 work, these issues were revisited to determine how best to address each one of them. Each item is addressed below.

4.7.1.1 Terminology

A large part of this phase of research has focused on the creation of definitions for the various functions identified as part of the functional validation and decomposition. The following glossaries and standards were identified as possibly being useful in developing the appropriate lexicon. Considerable work remains before a “standard” terminology for use in the RLV O&M guidelines and subsequent NPRM can be established.

1. **AIAA Standard Terminology for Space Structures**, S-001-1991

2. **AIAA Guide to Terminology for Space Launch Systems**, G-057-1994

3. **AIAA Standard Vocabulary for Space Automation and Robotics**, S-066-1995

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4.7.1.2 Compatibility with the 400-series 14 CFRs

This is an ongoing activity. Of particular concern is the relationship of the work coming out of this effort and the rules promulgated in FAR 431, Launch and Reentry of a Reusable Launch Vehicle. While no specific difficulties have been found to date, AST should expect that some clarifications and adjustments to the contents of 431 might be needed as the operations research work continues.

4.7.1.3 Areas of Overlap

The current breakout of Operations, Maintenance, Training, and Approval appears to be a useful way of grouping like things together. RTI suggests that these four areas might ultimately be appropriate Subchapter Titles for the resulting rules, similar to what has been done in the aviation community. Other candidates for Subchapters would include Licensing and in the future, Design, and Production. These groupings would allow for a more performance-based approach to the RLV-related rules than is currently found in the aviation FARs.

4.7.1.4 Design Dependencies

RTI continues to identify issues where any guidelines or promulgation of rules associated with RLV O&M will, by necessity, drive certain decisions during the design and production of an RLV. Care is being taken to ensure the proposed Guideline Input text is as design independent as possible. A critical concern of this approach is that the criteria by which a repair or alteration is to be measured is typically associated with an original/approved design.

4.7.1.5 Areas Requiring Coordination

Significant areas of coordination have been identified in the course of this research. As noted in the DO2 report, AST will likely need Memorandums of

Agreement (MOA) clearly denoting their jurisdictional authority with almost every other major Federal regulatory agency. Of highest priority are clear statements of authority between the FAA (AST) and the FCC, EPA, DOT, DOD, TSA, NTSB, and OSHA.

4.7.2 Original White Paper Questions

The RLV O&M Guidelines effort began with the issuance of a White Paper by the FAA to Industry that raised seven specific questions. The DO2 report offered an initial set of answers to these questions. This section takes up these questions again and provides an update on this effort to provide complete answers.

1. How much of the existing [Title] 14 CFRs applicable to aircraft O&M can be utilized for commercial RLVs?

   No new conclusions since the DO2 report.

2. What new [Title] 14 CFRs may be required to be developed?

   RTI is operating on the assumption that there will be, at a minimum, four sets of guidelines, and ultimately four rules developed that will be directly related to RLV O&M. These are:

   - RLV Operations
   - RLV Maintenance
   - RLV Training
   - RLV Approvals

   One additional consideration that will need to be addressed by the FAA is the difference between vehicles that are experimental in nature and those being licensed for revenue service. In traditional aviation, the FAA recognizes three tiers of “control” over aircraft approval. The first of these is experimental. This is employed for test aircraft. Homebuilt aircraft generally remain in this category for their entire lifespan. The second tier comes about by way of the recognition that an owner/operator of an aircraft should have some latitude in how they maintain their own aircraft. Many of the rules are written in such a way that the owner/operator is ultimately responsible for their own safety and have the final say on the acceptability of certain conditions with their own aircraft. The majority of the general aviation fleet falls into this second category. The third tier is reserved for operators who intend to operate a revenue service. Here the rules are quite stringent for both equipment and personnel.

   The first tier model appears to apply to RLVs under development, and would aid the industry in the short term since the initial flights will clearly be experimental. However, given that the FAA’s mandate

concerning public safety is focused on protection of third parties on the ground rather than solely focused on the safety of the vehicle occupants, it is more difficult to make a case for less stringent rules for experimental vehicles. It may be that an experimental designation coupled with SUAs may be an appropriate approach for experimental RLVs initially.

3. What regulatory safety guidelines need to be developed for this emerging industry to ensure public safety while new O&M regulations are being developed?

   The focused Subsystem and Functional data collection that has been completed during this phase of the research effort has resulted in numerous public safety issues being identified. See the accompanying volumes for specific data relating to this question.

4. What is the effect on RLV O&M requirements if humans are on-board?

   While this has largely been excluded from this activity due to other efforts being accomplished internally at the FAA, some humans on-board public safety concerns have surfaced, particular as it relates to the Environmental and Crew Subsystems. See the sections associated with these Subsystems for more information related to this question.

5. Can innovative practices such as the FAA's designee program be used for RLV licensing the same as it is being used in the aviation arena?

   No new conclusions since the DO2 report.

6. What areas of research and development are required to conduct RLV O&M programs that maintain the requisite level of safety?

   Of the list included in the DO2 report, RTI believes that focused research is most needed in the areas of TPS, FSS, Orbital Debris Management, and Health Monitors. To this list, RTI would add the following:
   - E_c calculations and assumptions in light of the Columbia loss
   - Terminology and Nomenclature for the RLV domain

7. What will be the eligibility, knowledge, skill, experience, and medical requirements for an aerospace mechanic or repairman and how will they differ from an aviation mechanic or repairman?

   RTI believes the answers to this question lie in understanding where public safety issues can arise in each Subsystem or Function and in the interactions between Subsystems and Functions. RTI is also

considering the issues of eligibility, knowledge, skills, experience, and medical requirements for ground and flight operations personnel. While not the principle focus of this research, RTI believes that it is better to capture the relevant issues in the course of looking at the overall question of RLV O&M.

4.7.3 Meta Topics

In the course of completing this phase of the RLV O&M effort, a number of topical areas have emerged that cut across multiple Functions and/or Subsystems. These "meta-topics" have been recognized in various ways within the aviation and space community, sometimes as system properties or characteristics and sometimes as engineering disciplines. In most cases, their biggest impact occurs during system design; however, in each of the topics identified so far, there is a clear need to include these topics as a consideration in the RLV O&M Guideline development. The current list of these topics incorporates the following areas:

1. Materials
2. System Safety
3. Human Factors
4. "ilities" - (Reliability, Quality, Maintainability, Supportability, etc.)
5. Reporting

In addition, the nature of software suggests that it would be more appropriate to address software as a meta-topic rather than as a distinct Subsystem. The exact approach to be used to address these meta-topics is yet to be defined and will need to be one of the topics taken up in the future. For the time being, data associated with the above items appears below.

The following sections provide a brief overview for each of the meta-topics. Each section concludes with a short list of references to be used as a starting point for exploring that topic further in future work. These lists are included to show a representative sample of the type of information that will need to be reviewed to assemble guidelines on each topic. The lists are not complete and further data collection will be needed for each topic.

4.7.3.1 Materials

Materials used in parts, processes, and testing as well as payloads and structures must possess adequate performance requirements in a given range of operational as well as environmental conditions. There may be cases where only new materials will be used to ensure their chemical and physical properties. Some critical properties are:

1. Hydrogen Embrittlement
2. Temperature, Vibration, and Pressure Tolerance

3. Stress Corrosion
4. Dissimilar Metals
5. Toxic Materials or Formulations
6. Flammability
7. Odor
8. Out-gassing
9. Compatibility with Fluids/Gases used (eg: oxygen compatibility)
10. Heat and Blast Protection
11. Fungus Resistance

References:

NASA Standards:

1. **Materials Selection Guideline**, NASA Materials and Processes Technical Information Systems (MAPTIS) MSFC-HDBK-527/JSC 09604
2. **Environmental Compatibility Guideline**, NASA Materials and Processes Technical Information Systems (MAPTIS) MSFC-HDBK-527/JSC: 09604
3. **Environmental Compatibility Guideline**, NHB 8060.1:
4. **Flammability**: NHB 8060.1
5. **Toxic Outgassing**, NHB 8060.1
6. **Thermal Vacuum Stability**, ASTM E595
7. **Corrosion**, MSFS-SPEC 522

RTCA Documents:

1. **Environmental Conditions and Test Procedures for Airborne Equipment**, DO-160D

SAE Documents:

1. **Aerospace Material Specifications** (there are over 2000 AMS')

ISO Requirements:

1. **Space Systems - Ground Support Equipment for use at Launch, Landing, or Retrieval Sites- General Requirements**, ISO 14625, 1999

The European Cooperation for Space Standardization (ECSS) Standards:

1. **ECSS-E-30 Mechanical: Part 1A Thermal control** 25 April 2000
2. **ECSS-E-30 Mechanical: Part 3A Mechanisms** 25 April 2000
3. **ECSS-E-30 Mechanical: Part 6A Pyrotechnics** 25 April 2000
4. **ECSS-E-30 Mechanical: Part 7A Mechanical parts** 25 April 2000

5. **ECSS-E-30 Mechanical: Part 8A Materials** 25 April 2000
6. **ECSS-E-30-01A Fracture control** 13 April 1999

4.7.3.2 System Safety

System Safety is defined as the application of engineering and management principles, criteria, and techniques to achieve acceptable risk, within the constraints of operational effectiveness, schedule, and cost throughout all phases of the system life cycle (ANSI/AIAA S-061-1998, Commercial Launch Safety). This definition is compatible with that given in the FAA System Safety Handbook:

> The safety analysis process for RLVs should address safety implications from all of the subsystems as well as those that can arise in interactions between these subsystems. Any redundancies, backup systems as well as risk mitigation techniques used must be examined/approved. Special attention must be given to sneak circuits, zonal safety, cascading failures, common mode failures, and detailed risks assessment. Attention must also be given to safety-related flight operations, maintenance, and training tasks that are assumed in the assessment in order to ensure acceptable levels of residual risk[16].

References:

1. **Certification Considerations For Highly Integrated Or Complex Aircraft Systems**, SAE International, ARP4754, November 1996
2. **Guidelines and Methods for Conducting the Safety Assessment Process on Civil Airborne Systems**, ARP4761, SAE International, December 1996
3. **System Safety Analysis Handbook,** System Safety Society
4. **Air Force System Safety Handbook**, August 1992
5. **FAA System Safety Handbook: Practices and Guidelines for Conducting System Safety Engineering and Management**, FAA (ASY), December 30, 2000
6. **Standard Practice for System Safety**, Mil-STD-882D, February 2000
7. **Fault Tree Analysis**, IEC 1025, 1990
8. **System Safety Requirements for ESA Space Systems and Associated Equipment**, ESA PSS-01-40, 1988
9. **System Safety Engineering and Management**, Harold E. Roland, Brian Moriarty, John Wiley & Sons, 1990
10. **Aircraft Safety**, Shari Stamford Krause, McGraw-Hill, 1996
11. **Commercial Aviation Safety**, ED. Alexander Wells, McGraw-Hill, 2001

4.7.3.3 Human Factors

Most functions associated with RLV O&M involve both humans and machines. The necessary interaction between humans and machines is defined as Human Factors. These interactions play a vital role in not just the piloting of the craft, but also operations, maintenance, training, and approval. There should be a thorough analysis of workload issues in each of these areas. Work saturation, distraction, boredom, fatigue, unclear indicators, wrong information, and spurious or missing alerts and warnings are all potential causes of unsafe conditions.

References:

1. **AIAA Guide to Human Performance Measurements**, G-035A-2000
2. **SAE Integration Procedures for the Introduction of New Systems to the Cockpit**, ARP4927, March 1995
3. **SAE Human Engineering Considerations in the Application of Color to Electronic Aircraft Displays**, ARP4032, April 1988
4. **SAE Communications and Navigation Equipment**, ARP4102/6, July 1988
5. **Job Aid – Human Factors**, FAA, March 4, 1999

4.7.3.4 "ilities" - (Reliability, Quality, Maintainability, Supportability, etc.)

There are a number of engineering disciplines, often referred to as the "ilities" that contribute to the safety of complex systems. While it is expected that most of these disciplines will have their greatest impact during design and production of an RLV, they also play a role in RLV O&M. For example, a quality function can be employed to ensure that O&M procedures are routinely and correctly followed. Similarly, the application of reliability principles in the course of conducting maintenance activities or predicting when such maintenance may be needed is expected to be key in ensuring that a vehicle maintains the appropriate safety margins as flight cycles and hours are accumulated. As noted during the DO2 effort and recommended in the Maintenance Guideline Input Volume, the application of Reliability Centered Maintenance (RCM) can significantly enhance safety. Guidelines for the application of the various “ilities” for RLV O&M should be investigated as part of a follow-on effort.

References:

1. **Quality Assurance**, The European Cooperation for Space Standardization (ECSS), ECSS-Q-20B, 8 March 2002
2. **Quality Assurance for Test Entries**, The European Cooperation for Space Standardization (ECSS), ECSS-Q-20-07A, 31 July 2002
3. **Nomenclature for Hazard and Risk Assessment in the Process Industries**, IChE85

4. **Quality Assurance Requirements for Nuclear Facility Applications**, ASME NQA -1
5. **Aviation Industry Quality Systems**, Michael Dreikorn, ASQC Quality Press, 1995

4.7.3.5 Reporting

Both voluntary and mandatory reporting programs are used to collect data on accidents, incidents, and service irregularities in the aviation field. Examples of these reporting systems include the Aviation Safety Reporting System (ASRS), Government and Industry Data Exchange Program (GIDEP), and Flight Operations Quality Assurance (FOQA). NASA also uses a reporting system for tracking issues related to their various programs called NASA Safety Reporting System (NSRS). These reporting systems are used in every facet of O&M and have contributed significantly to safety improvements over the years. A similar data sharing mechanism is both appropriate and necessary for the developing RLV Industry.

References:

1. **Aviation Safety Reporting System Website** - http://asrs.arc.nasa.gov/
2. **Government and Industry Data Exchange Program** - www.gidep.org
3. **HOWI 8710-Q017 Rev. B, OSMA Management of the NASA Safety Reporting System**
4. **Flight Operations Quality Assurance Program**, http://www.asy/faa.gov/gain/foqu_&_asap/foqa_&asap_information.htm

4.7.4 Technical Standard Order (TSO) Equipment

One avenue that some RLV developers may take to provide capability to their vehicles in as cost-effective manner as possible is the use of equipment previously approved by the FAA by way of the Technical Standard Order (TSO) system. Such equipment has been designed and built in accordance with a defined set of operational specifications and quality requirements. Although FAA/ AST does not currently evaluate and approve design and production, the use of TSO'd equipment may help facilitate the licensing process for those RLVs that have a substantial part of their flight profile that is similar or identical to a traditional aircraft. While many TSO's are simply not relevant to RLVs, it may be worth exploring which ones may have value in the RLV domain. The following table, Table 6, illustrates the broad categories of equipment for which TSO's exist. It may be the case that while the TSO itself is not usable; the performance specifications referenced by the TSO may be of some value in establishing O&M guidelines for specific systems. Even if a TSO looks applicable, there are issues of materials and environment that need to be considered.

Note: RTI does not advocate any requirement that would stipulate the use of TSO'd equipment for RLVs, even in well-established areas such as communications. Such a requirement at this point in time would be cost prohibitive and extremely damaging to the RLV Industry. Rather the inclusion of this material is simply to identify equipment for which TSO's exist and where the use of such equipment on a voluntary basis may lead more rapidly to an RLV capable of being more easily integrated into the NAS.

Table 6 Equipment Categories Covered by Aviation TSOs[i]

Equipment Category	Equipment Examples	Number of TSOs in this Category
Auto Flight	Automatic Pilots	1
Auxiliary Power	Auxiliary Power Units	1
Batteries	Lithium Batteries	2
Cargo Load Devices	Pallets, Nets, and Containers	1
Collision and Weather Avoidance	Traffic Advisory, Traffic Alert and Collision Avoidance, Ground Mapping Pulsed Radars	8
Communications Equipment	Microphones, Headsets, Various Radios (HF, VHF)	9
Electrical Power	Generators, Power Inverters	3
Equipment Furnishings	Seats, Safety Belts, Torso Restraint Systems	8
Evacuation and Survival Equipment	Emergency Locator Beacons, Personnel Parachute Assemblies	9
Fire Protection	Fire Detectors (multiple types), Carbon Monoxide Detectors, Fire Extinguishers	5
Fuel/Oil/Hydraulic	Flexible Cells, Drain Valves, Flow meters	3
Heaters	Combustion Heaters	1
Hose Assemblies	Oil Hose Assemblies, Hydraulic Hose Assemblies	3
Instruments (Engine, Flight)	Altimeters, Airspeed Indicators, Mach Meters, Temperature Instruments, Pressure Instruments	24
Landing Gear	Skis, Wheels, Brakes, Tires, Floats	4
Lights	Position, Anti-Collision	2
Navigation	Various Transponders, Global Positioning System Equipment, Various Landing Systems	24
Oxygen Equipment	Masks, Regulators	6
Parts	Bearings, Mechanical Fasteners, Seals	3
Recorders	Voice, Data	2

[i] Advisory Circular 20-110L, Index of Aviation Technical Standard Orders, FAA, 10/10/00

4.7.5 Inspector's Handbooks

These handbooks provide a detailed treatment of inspection processes and techniques for accomplishing oversight in accordance with the FARs. To the extent that the RLV O&M rules make use of the FARs directly or follow the model of the FARs, these handbooks may prove useful in establishing similar processes for reviewing RLV operator operations and maintenance data. Since this effort has thus far focused on developing guideline inputs at a high-level, these handbooks have not been fully explored. A detailed review should be a part of later work done for RLV O&M.

4.7.6 Communication, Navigation, and Surveillance/Air Traffic Management (CNS/ATM)

As noted in the DO2 Report[1], the FAA does not have a well-defined mechanism for the establishment of new rules for emergent technology. The development of RLV O&M Guidelines in advance of any formal rulemaking is one way of addressing this issue. In the course of developing Guideline inputs during this research phase (DO3), another reason has been identified as to why this approach is not only appropriate, but also necessary. Many RLV systems will need to interface with existing terrestrial infrastructure, particularly as it relates to Communication, Navigation, and Surveillance (CNS). All of these figure heavily in Air Traffic Management (ATM). Given the current modernization efforts underway in the FAA in all areas of CNS/ATM, RLV development is occurring in a rapidly changing NAS environment. This presents both the challenge of trying to meet a moving target and it also affords opportunity to ensure that FAA modernization efforts are extensible enough to accommodate the types of vehicles and flight profiles that RLVs represent. The accompanying Guideline Inputs volumes identify both functions and specific subsystems-related safety issues. These issues should serve as a starting point for developing requirements to feed into the modernization process.

5.0 Next Steps

This phase of the RLV O&M effort has been focused on the identification of the overall context for both Subsystems and Functions for which O&M Guidelines would be useful. The initial exploration of the identified Subsystems and top-level Functions has served to illustrate the magnitude of the task, as well as reinforce the need for RLV Industry involvement and coordination of the RLV O&M Guideline development effort. RTI envisions the next steps of this effort to include:

1. Further refinement of the Subsystem and Functional decomposition

   A number of modifications to the current Functional Decomposition diagrams have been identified; including the need to add Functions for Contingency, Vehicle Configuration, and Simulation to name just a few. The decision was made to hold these modifications to the next research stage to provide stability as this phase was completed. Incorporation of these updates will be the starting point for DO4.

2. Continued data collection from the aviation and space domains

   Previous work has drawn information from traditional aviation, the Space Shuttle, and other RLV programs. This data collection should continue. In addition, RTI sees the need to “track” the domain from which lessons and data are being drawn given that the space and aviation arenas have evolved so differently, the former being largely government driven, while the latter has been propelled by commercial concerns.

3. Further synthesis of material collected to date

   As part of DO2, and now DO3, a large effort has been expended to collect lessons-learned from earlier programs, as well as to review existing FAA policy (e.g. the FAR reviews). RTI believes that this work, while reflected throughout the current deliverables, can still yield additional insight as the Subsystem and Functional Decomposition continues. The subsequent phases of research need to explore how best to utilize this data. Possible avenues include the creation of an overall RLV O&M lessons-learned database that could be used by both AST and Industry as RLV's evolve.

4. Detailed exploration of Special Topics

   In DO2, a number of special topics were identified including inter/intra-agency coordination, terminology, and design dependencies. DO3 added a discussion of meta-topics including materials, human factors, safety, and the various “-ilities” (e.g. reliability, maintainability, availability, etc.). In many cases, these areas overlap with work being accomplished by other

groups within AST. RTI believes that each of these areas warrants additional investigation, particularly inter/intra-agency coordination. A deeper exploration of these areas had been planned for DO3, but was deferred after consultation with the FAA. Inter and Intra-agency coordination issues should be bounded to only to those items that could create a jurisdictional conflict for the proposed guidelines.

5. Initial development of candidate criteria for readiness reviews

   DO2 introduced the concept of both an Operational Readiness Review and a Maintenance Readiness Review as part of the Licensing process. Now that work has begun on the Functional Decomposition, RTI believes that the definition of candidate criteria for these reviews can now begin. During subsequent phases, another focus could be on identifying the basic information that any RLV developer should bring forward to demonstrate that they have accomplished the necessary planning to ensure the public safety throughout RLV O&M.

The outputs of the next phases are likely to be updates to the five Guideline Inputs volumes. The evolution of the deliverables for this research effort are illustrated in Figure 13. General Considerations (Vol 1) and Operations Considerations (Vol 2) RLV O&M Guideline Inputs and Technical Evaluation Report will be developed and delivered under the next phase, DO4. These will include the Guideline Inputs and their rationale in the format prescribed by FAA/AST. The Maintenance Considerations (Vol 3), Training Considerations (Vol 4) and Approval Considerations (Vol 5) RLV O&M Guideline Inputs and Technical Evaluation Report will be developed and delivered beyond DO4 (DO4+). These will be in the same format as Volumes 1 and 2.

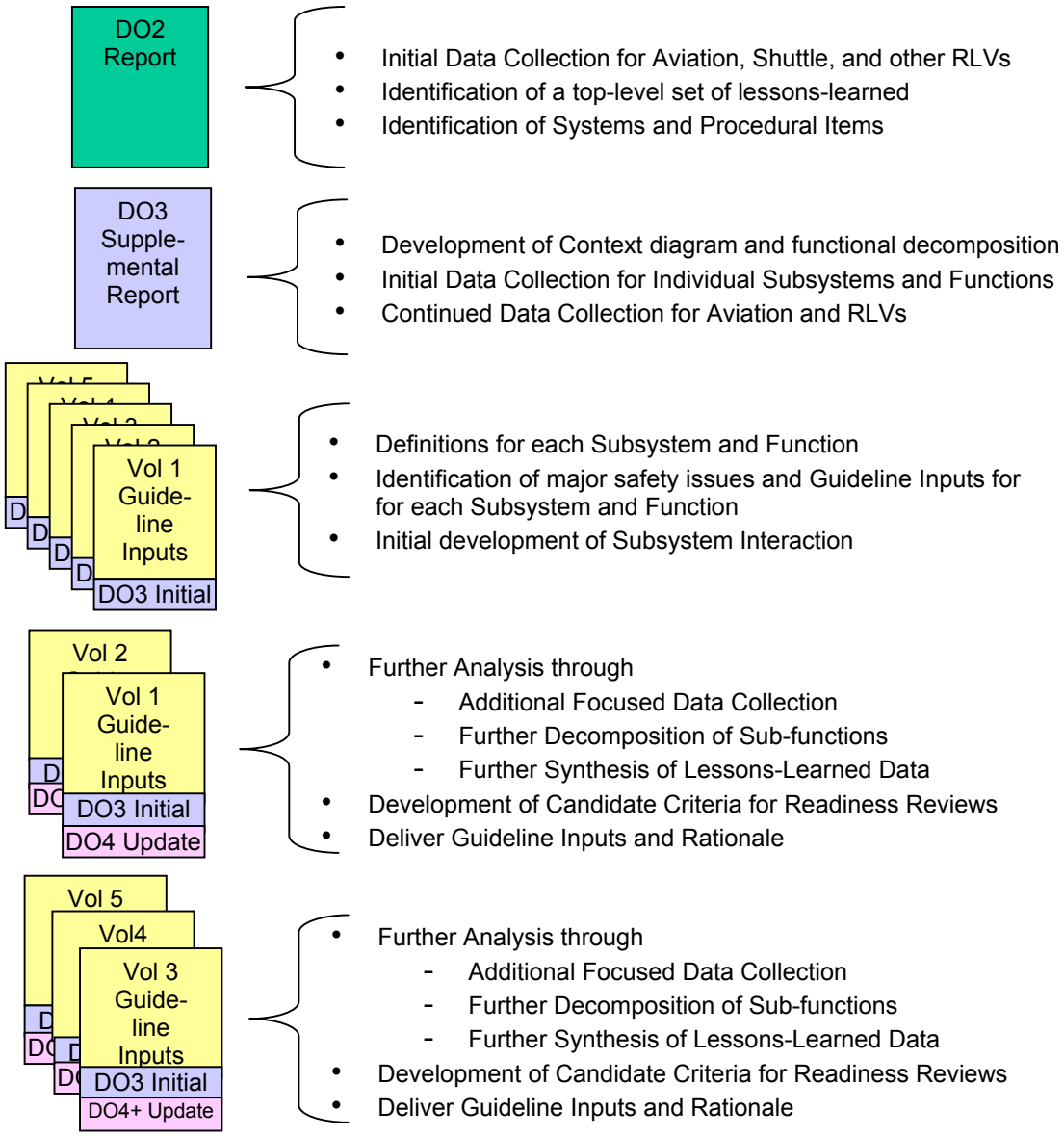

Figure 13 Evolution of RLV O&M Research Development

All of the above activities would benefit from increased communication with industry. RTI suggests that, with coordination through AST, additional communication with current RLV developers and the on-site visits previously planned for DO3 be conducted during this next research phase. This will allow some validation of the work accomplished to date as well as allow the effort to move to the next level of detail.

Additional areas where work could and probably needs to be done to ensure the completeness of this overall effort include:

1. Validation of the Guideline Inputs both through table-top exercises and comparison with data from previous accidents/incidents;

2. Creation (or borrowing from another domain) of a process for rapidly evaluating new technology being brought forward for use in RLVs for which licensing is being sought;
3. Formulation of a true RLV Concept of Operations that extends into the functional areas identified by this work;
4. Further exploration of management models for completing the required oversight functions to ensure public safety with as minimal an impact to the fledgling RLV Industry as possible.

6.0 Conclusion

This research effort has focused on the validation and further decomposition of the Subsystems and Functions previously identified in DO2. Initial data collection and synthesis has been accomplished for the Subsystems and the top-level Functions. Where possible, specific Guideline Inputs have been identified. The Guideline Inputs Volumes include the identification of major safety issues associated with the various Functions and Subsystems. Work begun under DO2 to review the various aviation-related rules has been continued, as has the exploration of current practices employed by both government and private space-related organizations. This report and the five Guideline Inputs Volumes capture the complete output of the DO3 effort. This report provides the necessary baseline of technical information that will lead to a comprehensive set of RLV O&M guidelines.

Appendix A Acronyms/Terminology

AAAF	Association Aéronautique et Astronautique de France
A&P	Airframe & Powerplant
A/C	Aircraft
AC	Advisory Circular
AD	Airworthiness Directive
ADIZ	Air Defense Information Zones
AETB	Alumina Enhanced Thermal Barrier
AFS	Aviation Flight Standards
AIAA	American Institute of Aeronautics and Astronautics
ALARA	As Low As Reasonably Achievable
AM	Amplitude Modulation
AMF	Astronauts Memorial Foundation
ANPRM	Advanced Notice of Proposed Rule Making
ANSI	American National Standards Institute
AOG	Airplane on Ground
APU	Auxiliary Power Unit
ARAC	Aviation Rulemaking Advisory Committee
ARC	Ames Research Center
ARF	Assembly and Refurbishment Facility
ARINC	Aeronautical Radio, Inc.
ARP	Aerospace Recommended Practice
ASEE	American Society for Engineering Education
ASICS	Application Specific Integrated Circuits
	ASME American Society of Mechanical Engineers
ASQ	American Society for Quality
AST	Office of the Associate Administrator for Commercial Space Transportation
ASTM	American Society for Testing and Materials
ASTWG	Advance Spaceport Technology Working Group
ASW	Aerospace Worthiness Standards
ATA	Air Transport Association
ATAC	Advanced Technology Advisory Committee
ATC	Air Traffic Control
ATC-O	Aerospace Traffic Control Operator
ATM	Air Traffic Management

ATOS	Air Transport Oversight System
ATSRAC	Aging Transport Systems Rule Making Advisory Committee
AVCS	Air Vehicle Control Station
BCSP	Board of Certified Safety Professionals
BFE	Buyer Furnished Equipment
BITE	Built In Test Equipment
BPSK	Bit Phase Shift Keying
CAA	Civil Aviation Authorities
CAM	Civil Aeronautics Manual
CAR	Code of Aviation Regulations
CASA	Civil Aviation Safety Authority
CASS	Continuous Analysis and Surveillance
CAST	Civil Aviation Safety Team
C-Band	Frequency range between 3.6 and 4.2 GHz
CCAFS	Cape Canaveral Air Force Station
CDR	Critical Design Review
CEI	Contract End Item
CEO	Chief Executive Officer
CFR	Code of Federal Regulations
CIL	Critical Items List
CINCSPACE	Commander In Chief, Space Command
CMR	Certification Maintenance Requirements
CO_2	Carbon Dioxide
COFR	Certificate of Flight Readiness
COLA	Conjunction On Launch Assessment or Collision Avoidance
COMBO	Computation of Miss Between Orbits
COMSTAC	Commercial Space Transportation Advisory Committee
CONOPS	Concept Of Operations
CONUS	Continental United States
CRM	Cockpit Resource Management
CRV	Crew Return/Rescue Vehicle
CVR	Cockpit Voice recorder
dB	Decibel
DACUM	Developing A Curriculum
DARPA	Defense Advanced Research Projects Agency
DCC	Division of Community College
DCN	Document Change Notice
DFRC	Dryden Flight Research Center

DMS	Docket Management System
DNPS	Delaware North Park Services
DO	Delivery Order
DoD	Department of Defense
DOF	Degrees of Freedom
DOT	Department of Transportation
E_c	Casualty Expectation
EIS	Environmental Impact Statement
EFI	Enterprise Florida, Inc.
ELV	Expendable Launch Vehicle
EMC	Electromagnetic Compatibility
EMI	Electromagnetic Interference
EOM	End Of Mission
EPA	Environmental Protection Agency
ESA	European Space Agency
ESD	Electrostatic Discharge
ESMC	Eastern Space and Missile Center
ET	External Tank
ETMS	Enhanced Traffic Management System
ETOPS	Extended Twin (engines) Operations
FAA	Federal Aviation Administration
FAR	Federal Aviation Regulation
FCC	Federal Communications Commission
FHA	Functional Hazard Assessment
FL	Florida
FM	Frequency Modulation
FMEA	Failure Modes and Effects Analysis
FMEA/CIL	Failure Modes and Effects Analysis/Critical Items List
FMECA	Failure Modes, Effects, and Criticality Analysis
FMS	Flight Management System
FOCC	Flight Operations Control Center
FOQA	Flight Operations Quality Assurance
FR	Flight Recorder
FRCS	Forward Reaction Control System
FRR	Flight Readiness Review
FSDO	Flight Standards District Office
FSO	Flight Safety Officer
FSS	Flight Safety Systems
FTD	Flight Training Devices
FTS	Flight Termination Systems
FY	Fiscal Year
G	Gravitation Acceleration at Sea Level

GLONASS	Global Orbiting Navigation Satellite System
GNC	Guidance, Navigation, Control
GNSS	Global Navigation Satellite System
GOR	Ground Operations Review
GPS	Global Positioning Satellite
GRC	Glenn Research Center
GSE	Ground Support Equipment
GSO	Ground Safety Officer
GSRP	Ground Safety Review Panel
GSS	Ground Support System
HAZMAT	Hazardous Material
HBAT	Handbook Bulletin for Air Transportation
HCF	High Cycle Fatigue
HDTV	High Definition Television
HMI	Human-Machine Interface
HMF	Hypergolic Maintenance Facility
HRST	Highly Reusable Space Transportation
HTHL	Horizontal Take Off and Landing
HTVL	Horizontal Take Off and Vertical Landing
HW	Hardware
IASA	International Aviation Safety Assessment
ICA	Instructions for Continued Airworthiness
ICAO	International Civil Aviation Organization
ICF	Instructions for Continued Flightworthiness
ICHM	Integrated Control and Health Management
IEC	International Electrotechnical Commission
IEEE	Institute of Electrical and Electronic Engineers
IFR	Instrument Flight Rules
ILL	Impact Limit Lines
ILS	Instrument Landing System
IMU	Inertial Measurement Unit
ISO	International Organization for Standardization
ISS	International Space Station
ITU	International Telecommunication Union
IVHM	Integrated Vehicle Health Monitoring
IV&V	Independent Validation and Verification
JAA	Joint Aviation Authorities

JAR[1]	Joint Airworthiness Regulations
JAR[2]	Joint Aviation Regulations
JAR-VLA	Joint Aviation Regulations-Very Light Airplanes
JROC	Joint Requirements Oversight Council
JSC	Johnson Space Center
Klb	Kilo Pound
Klbs	Kilo Pounds
KSC	Kennedy Space Center
Ku-Band	Frequency Range from 1.7 to 12.76 GHz
LA	Los Angeles
LCC	Launch Control Complex
LH2	Liquid Hydrogen
LOA	Letter of Agreement
LEO	Low Earth Orbit
LLC	Limited Liability Corporation
LOX	Liquid Oxygen
LRCS	Long-Range Communication System
LRU	Line Replaceable Units
MMEL	Master Minimum Equipment List
MEL	Minimum Equipment List
MLP	Mobile Launcher Platform
MMH	Monomethyl Hydrazine
MNPS	Minimum Navigation Performance Specifications Airspace
MRB	Maintenance Review Board
MRM	Maintenance Resource Management
MRO	Maintenance, and Repair, Overhaul
MSFC	Marshall Space Flight Center
MSG	Maintenance Steering Group
MSI	Maintenance Significant Items
MSL	Mean Sea Level
N/A	Not Applicable
NAI	National Aerospace Initiative
NAS	National Airspace System
NASA	National Aeronautics and Space Administration
NASP	National Aerospace Plane
NAT	North Atlantic
NDE	Non Destructive Evaluations
NIDA	NIDA Corporation
NORAD	North American Aerospace Defense Command
NOTAM	Notice To Airmen
NOTMAR	Notice To Mariners
NPRM	Notice of Proposed Rulemaking

NSP	National Simulator Program
NSLD	NASA Shuttle Logistics Depot
NSTS	National Space Transportation System
NTSC	National Television System Committee
O_2	Oxygen
O&M	Operations and Maintenance
O&S	Operations and Supportability
OEI	One Engine Inactive
OEM	Original Equipment Manufacturer
OJT	On-the-Job Training
OMD	Operations and Maintenance Document
OMDP	Orbiter Maintenance Down Period
OMI	Operations and Maintenance Instructions
OMRS	Operations and Maintenance Requirements Specifications
OMRSD	Operations and Maintenance Requirements Specifications Document
OMS	Orbital Maneuvering System
OPF	Orbital Processing Facility
ORR	Orbiter Readiness Review
OSD/AF	Office of Scientific Development/Air Force
OSHA	Occupational Safety and Health Administration
OSI	Open Systems Interconnect
P_i	Probability of Impact
PAL	Phase Alternation Line
PCM	Pulse Code Modulation
PiC	Pilot in Command
PLC	Programmable Logic Controller
PMA	Parts Manufacturer Approval
PMD	Propellant Management Devices
PMI	Principle Maintenance Inspectors or Preventative Maintenance Inspection
PoC	Point of Contact
PRACA	Problem Reporting and Corrective Action
PRR	Payload Readiness Review
PSI	Pounds per Square Inch
PSRP	Payload Safety Review Panel
Pt.	Part
PVAT	Position, Velocity, Attitude, Time
Q-D	Quantity Distance

QD	Quick Disconnects
QoS	Quality of Service
QPSK	Quadrature Phase Shift Keying
RCM	Reliability Centered Maintenance
RCS	Reaction Control System
RF	Radio Frequency
RLV	Reusable Launch Vehicle
RNAV	Area Navigation
RPM	Revenue Passenger Mile
RPR	Rulemaking Project Record
RPSF	Rotation, Processing & Surge Facility
RSO	Range Safety Officer
RSRM	Reusable Solid Rocket Motor
RSS	Range Safety System
RTG	Radioisotope Thermoelectric Generator
RTI	Research Triangle Institute
RTS	Return To Service
RTV	Room Temperature Vulcanizing
RVT	Reusable Vehicle Test
SAE	Society of Automotive Engineers
SATMS	Space and Traffic Management System
SCAPE	Self-Contained Atmospheric Protective Ensemble
SDP	Safety Data Package
SDR	Service Difficulty Report
SFE	Supplier Furnished Equipment
SGS	Space Gateway Support
SIAT	Shuttle Independent Assessment Team
SLF	Shuttle Landing Facility
SLI	Space Launch Initiative
SME[1]	Shuttle Main Engine
SME[2]	Subject Matter Expert
S/N	Stock Number
SNPRM	Supplemental Notice of Proposed Rule Making
SOH	State of Health
SOP	Standard Operating Procedure
SPST	Space Propulsion Synergy Team
SRB	Solid Rocket Booster
SRD	Systems Requirements Document
SRM	Solid Rocket Motor
SRSO	Senior Range Safety Officer
SSA	System Safety Assessment
SSB	Single Side Band
SSME	Space Shuttle Main Engine

SSP	Space Shuttle Program
SSTO	Single Stage To Orbit
SSV	Space Shuttle Vehicle
STC	Space Traffic Control
STS	Space Transportation System
SUA	Special Use Airspace
SUP	Suspected Unapproved Parts
SW	Software
TAL	Transoceanic Abort Landing
TBD	To Be Determined
TCAS	Traffic Alert and Collision Avoidance System
TOGA	Take-Off/Go-Around
TPS	Thermal Protection System
TSA	Transportation Security Administration
TSO	Technical Standard Order
TSOA	Technical Standard Order Authorization
TSPI	Time Space Position Information
TSTO	Two Stage To Orbit
TVC	Thrust Vector Control
UAV	Unmanned Aerial Vehicle
US	United States
USAF	United States Air Force
USBI	United States Boosters, Inc.
USC	United States Code
VAB	Vehicle Assembly Building
VFC/MFC	Maximum Speed For Stability Characteristics
VDF/MDF	Demonstrated Flight Diving Speed
VFR	Visual Flight Rules
VHF	Very High Frequency
VOR	VHF Omnidirectional Range (navigation system)
VSP	Vision Spaceport Program
VTHL	Vertical Take Off and Horizontal Landing
VTVL	Vertical Take Off and Landing
WSMC	Western Space and Missile Center
WWI	World War 1
Wx	Weather

Appendix B Past and Current RLV Concepts/Programs

The following table provides a summary of prospective RLV concepts. They are categorized as: X-Prize Entrants, U.S. Government/Industry Partners, Start Up Commercial Concerns, and Hobbyists/Fully Experimental/Other.

X-Prize Entrants

COMPANY	LOCATION	VEHICLE NAME	FLIGHT PROFILE	STATUS	NOTES
Acceleration Engineering	Bath, Michigan, USA	Lucky Seven	VTOL-SSTO	Active	Parafoil Landing using GPS
Advent Launch Systems (2)	Houston, Texas, USA	Advent Mayflower	VTOHL	Active	Water Takeoff and Landing
Aeroastro LLC	Herndon, Virginia, USA	PA-X2	VTOL-SSTO	Not listed as a X-prize team	Parafoil Landing
Aeronautics and cosmonautics Romanian Association - ARCA	Rimmicu Vilcea, Romania	Orizont	VTOL	Active	Vertical from ground, Ballistic reentry and parachute descent into water
American Astronautics Corporation	Oceanside, CA, USA	The Spirit of Liberty	VTVL	Active	Vertical launch from coastal region and unpowered parachute descent into water
Armadillo Aerospace	Possible launch site- OK, USA	Black Armadillo	VTVL-SSTO	Active	Single passenger craft tested.
Bristol Spaceplanes LTD (2)	Bristol, England	Ascender (Spacecab and Spacebus to follow)	HTOL-SSTO	Active	Conventional Runway
Canadian Arrow	Toronto, Ontario, Canada	Canadian Arrow	VTVL	Active	Ram Air Balloon Transition to Three Main Chutes –Water Landing (chute water landing for both stages)
Cerulean Freight Forwarding Company	Oroville, Washington	Kitten	HTOL-SSTO	Not listed as x-prize team, company restructured	Conventional Runway
DaVinci Project	Toronto, Ontario, Canada	Wild Fire	VTOL-TSTO	Active	Air launch from balloon and parachute descend
Discraft Corporation	Portland Oregon	The Space Tourist	HTOL-SSTO	Active	Conventional Runway, Disc with fixed angle take off and flared landing
Earth Science Transport System	Highlands Ranch, Colorado	Unnamed	Undisclosed		
Flight Exploration	United Kingdom	The Green Arrow	VTOL-SSTO	Active	Parachute Landing
Fundamental Technology Systems (3)	Orlando, Florida	Aurora	HTOL-SSTO	Active	Conventional Runway, Glide Descent
IL Aerospace	Zichon	Negev 5	VTVL	Active	Air launch from balloon,

X-Prize Entrants

COMPANY	LOCATION	VEHICLE NAME	FLIGHT PROFILE	STATUS	NOTES
Technologies	Ya'akov, Israel				parachute landing
Interorbital Systems (IOS)	Mojave, CA, USA	Solaris X	VTHL	Active	
Kelly Space and Technology (Private)	San Bernardino, California	LB-X	HTOL-TSTO	Active, Teamed with Voight Aircraft to further develop concept	Conventional Runway,Air towed launch from 747 ,Glide Descent to conventional runway
Lone Star Space Access	Houston, Texas	Cosmos Mariner	HTOL - SSTO	Active	Conventional Runway
Micro-space, Inc.	Denver, CO, USA	Crusader X	VTVL	Active	Rocket powered vertical takeoff, parachute recovery
Pablo De Leon & Associates	Buenos Aires, Argentina	Gauchito (The Little Cowboy)	VTOL-SSTO	Not listed as an X-prize team, Scaled capsule test from 32km	Parachute landing both stages
PANAERO	Fairfax, VA, USA	SabreRocket	HTVL	Active	Jet and rocket powered horizontal takeoff and vertical landing at conventional runway
Pioneer Rocketplane, Inc. (Private)	Solvang, CA, USA	Pioneer, XP	HTOL-1.5STO	Active, awarded a phase one contract for the Defense Advanced Research Projects Agency's Responsive Access, Small Cargo, Affordable Launch program.	Conventional Runway, Turbo fan powered takeoff to load LOX
Scaled Composites	Mojave, CA, USA	White Knight, SpaceShipOne	HTHL	Active	Air launch, un-powered landing (glide) to conventional runway
Scaled Composites, LLC	Mojave, California	Proteus	HTOL-TSTO	Already flying, System may be on hold until the X-Prize is fully	Air Launch and Powered Landing

X-Prize Entrants					
COMPANY	**LOCATION**	**VEHICLE NAME**	**FLIGHT PROFILE**	**STATUS**	**NOTES**
				funded or another team arises as a serious threat to win	
Starchaser Industries	United Kingdom, Cheshire, England	Thunderbird	VTOL-SSTO	Active	Jet Powered Vertical Takeoff, Parachute recovery for both stages
Suborbital Corporation	Moscow, Russia	Cosmopolis-21 (C-XXXI)	HTOL-TSTO	Active	Launched off top of aircraft land in conventional runway
TGV	Bethesda, Maryland	Michelle-B	VTOL-SSTO	Active	Vertical/Soft Landing With Reduced Engine Power

U.S. Government/Industry Partners

AGENCY	LOCATION	VEHICLE NAME	FLIGHT PROFILE	STATUS	NOTES
NASA	Kennedy Space Center	Space Transportation System	VTHL	Aging Fleet	Partially Reusable
NASA/ Lockheed		X-33 Venture Star (Reusable 1-Stage, Lifting body)	VTHL Pilot less	Failure of composite H2 tanks caused severe delays. This plus various other problems caused significant overruns and the project was canceled. NASA: invested $912 million Lockheed Martin: invested $356 million	Vertical Takeoff Glide Landing
NASA/Orbital Sciences		X-34 (Reusable 1-stage suborbital)		Canceled after cost growth due to significant late hardware changes. These came after the Mars Lander failure led to review of all major NASA programs. NASA: $205 million expended on the X-34 project	Dropped from carrier plane
NASA/Boeing		X-37 (Reusable, unmanned, space vehicle)		Joint program of NASA & Air Force. However, the AF recently decided not to provide more funding after the current X-40 tests finish. NASA will apparently continue with the program through one space flight test.	Test various technologies and applications of space maneuvering vehicle for military and civilian uses
NASA		X-38 (Reusable lifting body)		Several successful low altitude drop flights. Budget overruns in ISS program, however, have postponed the Crew Return/Rescue Vehicle (CRV). Negotiations to continue the program with European funding are apparently on going.	Autonomous re-entry & landing Prove technology for space station CRV Para-foil Landing. Carried to orbit by shuttle. Test flights via B-52 drop.
USAF		X-40A (85% scale version of X-37)		Several drop landings succeeded and more scheduled.	Test autonomous landing, parafoil, and other technologies needed for X-37
NASA/ Microcraft		X-43A (Unpiloted 2-stage suborbital)		First flight failed due to failure in the Pegasus booster.	Dropped from carrier plane,

U.S. Government/Industry Partners

AGENCY	LOCATION	VEHICLE NAME	FLIGHT PROFILE	STATUS	NOTES
				Schedule for further flights depends on review board findings.	Pegasus booster releases hypersonic non-recovered vehicle
USAF/Airforce Research Laboratory		Bladerunner	HT		
Starcraft Booster, Inc.				Active	
USAF/ McDonnell Douglas		DC-X/DCXA (Low altitude vehicle that tested low cost reusable technologies and operations)	VTVL	Started as a project in the Missile Defense program. After 5 flights transferred to NASA. Demonstrated that a rocket vehicle could be flown by a small team and turned around between flights in 26 hours. All goals met but vehicle lost when leg failed to deploy on landing.	Single Stage, Vertical takeoff and landing.
		X-15 Reusable rocketplane		Of Historical Interest: Very successful program. Nearly 100 flights made over a decade. Big influence on the X-20 Dynasoar program and later the shuttle	Dropped from B-52. Learned how to deal with transition from atmosphere to near vacuum region and with the high temperatures on reentry

Start-Up Commercial Concerns

COMPANY	LOCATION	VEHICLE NAME	FLIGHT PROFILE	STATUS	NOTES
Kistler Aerospace	Woomera Australia, Nevada test site	K-1	VTVL-TSTO	Needs private funds to launch in Woomera, Australia	Parachute Landing, Airbag Cushion
Rotary Rocket		Roton	VTVL	Liquidated, Needed $120M to get operational	
Vela Technology Development		Space Cruiser/ Space Lifter System 2-Stage suborbital (2 pilots & 6 passengers for SpaceCruiser, 2 pilots for SpaceLifter)	HTHL	Never publicized any hardware tests, so it seems the project, if not canceled, is in permanent limbo	
Armadillo Aerospace		VTVL Lander	VTVL	Active, Not officially a X Prize competitor, although they may purse the competition if their VTOL development progresses well.	
JP Aerospace		Darksky Station		Active	loft launch system to an altitude of 100,000 feet by balloon
Venture Star (Lockheed Seed)		Venture Star	SSTO, VTHL		
Third Millennium Aerospace		MMI Launch Vehicle			
Starchaser	UK	SHARP 1 – 5			Parachute Recovery
Space Access	Possible launch sites in Texas Spaceport, Homestead Air Reserve, FL, and KSC, FL	SA-1	HTHL and 2-3 stages depending upon the payload requirements	Active	
XCOR	Mojave Desert	Xerus	HTHL	Active	Conventional Runway, EZ-Rocket being used for proving the concepts.

Hobbyists/Fully Experimental/Other

COMPANY	LOCATION	VEHICLE NAME	FLIGHT PROFILE	STATUS	NOTES
	Russia	Angara Heavy Lift Russian Launch Vehicle			
Russian Central Research Institute of Machine Building	Russia	Norma			Partially Reusable STS
	Russia	Buran Space Shuttle			
Russian Molniya Scientific Production Association/ Zhukovskiy Central Aerodynamics Research Institute	Russia	Multi-Purpose Aerospace System (MAKS ,Russian acronym)			
	Russia	Spiral Winged Spacecraft			
	Russia	EPOS Reusable Winged Spacecraft			
	Russia	BOR Reusable Winged Spacecraft			
Russian Space Agency	Russia	TU-2000 SSTO With the Orel R&D Program			
ISAS	Japan	RVT (Reusable Vehicle Test)	VTVL	Project of ISAS, the smaller of the two Japanese space agencies.	Single Stage, Vertical takeoff and landing,
Japanese Rocket Society	Japan	Kankoh-Maru	VTVL		
	German	Hopper Reusable lifting body. 7m long, 3.8m wingspan, 1200kg		German project. Funding approved. First flight test at end of 2003.	Intended for drop tests like X-38 & X-40. Prepare for orbital Phoenix vehicle.
Applied Astronautics		Hyperion	HT - orbital/suborbital		
Interorbital Systems Corporation		Neptune	Sea-launched orbital		

Hobbyists/Fully Experimental/Other					
COMPANY	**LOCATION**	**VEHICLE NAME**	**FLIGHT PROFILE**	**STATUS**	**NOTES**
Olson		Pogo	HT orbital		
Space Clipper International		SC-1 and SC-2	VT		
Burkhead		SpaceCub	VT suborbital		
Starcraft Boosters, Inc.		Starbooster	VT suborbital		
Star-Raker Associates		Star-Raker	HT orbital		
University of CA at Davis		Swiftlaunch	HT orbital		
Formation		The ET Scenario	VT orbital		
Canyon Space Team		XPV	HT suborbital		
SpaceDev		unnamed	suborbital		
Rocketguy		R.U.S.H	VT parachute landing		

Note: Information on RLVs efforts currently planned or underway is extremely fluid. RTI's primary focus for the initial O&M work is on those RLV concepts that are actively funded and have a defined schedule. However, every effort will be taken to ensure novel technologies arising from the work of the hobbyists and pure R&D efforts are catalogued so that they may serve as test cases for the flexibility and completeness of the resulting regulations.

Appendix C 14 CFR Review Results

The following tables provide the detailed review results for the 14 CFR reviews conducted during DO3. As noted in Section 3.1.1.1, these reviews supplement those previously accomplished under DO2. Additional 14 CFR reviews are planned in subsequent research phases.

The first table provides the overall list of 14 CFRs administered by the FAA along with the planned review phase based on the current definition of the O&M RPR work. This table has been updated to reflect the deferral of FAR 25 to a future phase of this effort. The subsequent tables provide the review details for each Phase 2 Title 14 CFR in turn. They consist of paragraph number, title, summary of contents, and any notes or questions raised as to how that paragraph might apply to RLVs. Please note that the intent of this review was not to identify what would need to change in the 14 CFR to make it applicable to RLVs, but rather to understand the intent of the 14 CFR so that a determination could be made as to whether the underlying issue the 14 CFR was trying to address applied to RLVs. For purposes of administration, it is assumed that a separate and distinct set of O&M RLVs will be created rather than modifying the 14 CFRs that are already in place for traditional aviation.

Note: As these tables are used in guiding the remaining data analysis and synthesis activities, they may be updated with additional notes and questions. In other words, these tables were designed as a tool to be used throughout the NPRM effort.

Overall 14 CFR (FARS) List and Associated Review Phases

This effort is Phase II.

This sheet provides an overall list of 14 CFR parts (FARS) that may be of interest to the RLV O&M effort.

The following fields are included:

CFR Part # - Identifier of Part in the CFR
Title - Complete title of the FAR Part
 # Sub-Parts - Number of separate topical paragraphs within the Part
Primary Focus - A General description of the area covered by the FAR
Review Phase - Targeted phase for review of that Part. Where multiple phases are indicated, it is expected that the majority of the part may be deferred after an initial review. Some Phase III items may not need to be reviewed at all (e.g. Agricultural Use).
Notes - Miscellaneous

CFR Part #	Title	Primary Focus (Ops, Maint, Dsgn, Proc, Othr)	RLV O&M Review Phase
Subchapter A - Definitions			
1	Definitions And Abbreviations	**Othr**	I
Subchapter B - Procedural Rules			
11	General Rulemaking Procedures	Proc	I
13	Investigative And Enforcement Procedures	Proc	I
14	Rules Implementing The Equal Access To Justice Act Of 1980	Proc	III
15	Administrative Claims Under Federal Tort Claims Act	Proc	III
16	Rules Of Practice For Federally Assisted Airport Enforcement Proceedings	Proc	III
17	Procedures For Protests And Contracts Disputes	Proc	III
Subchapter C - Aircraft			

CFR Part #	Title	Primary Focus (Ops, Maint, Dsgn, Proc, Othr)	RLV O&M Review Phase
21	Certification Procedures For Products And Parts	Dsgn, Maint	I
23	Airworthiness Standards: Normal, Utility, Acrobatic, And Commuter Category Airplanes	Dsgn	I,II
25	Airworthiness Standards: Transport Category Airplanes	Dsgn	III
27	Airworthiness Standards: Normal Category Rotorcraft	Dsgn	III
29	Airworthiness Standards: Transport Category Rotorcraft	Dsgn	III
31	Airworthiness Standards: Manned Free Balloons	Dsgn	III
33	Airworthiness Standards: Aircraft Engines	Dsgn	I,II
34	Fuel Venting And Exhaust Emission Requirements For Turbine Engine Powered Airplanes	Dsgn	I,II
35	Airworthiness Standards: Propellers	Dsgn	III
36	Noise Standards: Aircraft Type And Airworthiness Certification	Dsgn	III
39	Airworthiness Directives	Dsgn	I
43	Maintenance, Preventive Maintenance, Rebuilding, And Alteration	Dsgn	I
45	Identification And Registration Marking	Dsgn	III
47	Aircraft Registration	Dsgn	III
49	Recording Of Aircraft Titles And Security Documents	Dsgn	III
Subchapter D - Airmen			
61	Certification: Pilots, Flight Instructors, And Ground Instructors	Ops	II
63	Certification: Flight Crewmembers Other Than Pilots	Ops	II
65	Certification: Airmen Other Than Flight Crewmembers	Maint	I
67	Medical Standards And Certification	Ops	II
Subchapter E - Airspace			
71	Designation Of Class A, Class B, Class C, Class D, And Class E Airspace Areas; Airways; Routes; And Reporting Points	Ops	III

CFR Part #	Title	Primary Focus (Ops, Maint, Dsgn, Proc, Othr)	RLV O&M Review Phase
73	Special Use Airspace	Ops	II
77	Objects Affecting Navigable Airspace	Ops	III
Subchapter F - Air Traffic and General Operating Rules			
91	General Operating And Flight Rules	Ops	I
93	Special Air Traffic Rules And Airport Traffic Patterns	Ops	II
95	IFR Altitudes	Ops	II
97	Standard Instrument Approach Procedures	Ops	II
99	Security Control Of Air Traffic	Ops	II
101	Moored Balloons, Kites, Unmanned Rockets And Unmanned Free Balloons	Ops	III
103	Ultralight Vehicles	Ops	III
105	Parachute Operations	Ops	II
Subchapter G - Air Carriers and Operations for Compensation or Hire: Certification and Operations			
119	Certification: Air Carriers And Commercial Operators	Ops, Maint	II
121	Operating Requirements: Domestic, Flag, And Supplemental Operations	Ops, Maint	II
125	Certification And Operations: Airplanes Having A Seating Capacity Of 20 Or More Passengers Or A Maximum Payload Capacity Of 6,000 Pounds Or More; And Rules Governing Persons On-board Such Aircraft	Ops, Maint	III
129	Operations: Foreign Air Carriers And Foreign Operators Of U.S.-Registered Aircraft Engaged In Common Carriage	Ops, Maint	III
133	Rotorcraft External-Load Operations	Ops, Maint	III
135	Operating Requirements: Commuter And On Demand Operations And Rules Governing Persons On-board Such Aircraft	Ops, Maint	I,II
137	Agricultural Aircraft Operations	Ops, Maint	III
139	Certification And Operations: Land Airports Serving Certain Air Carriers	Ops, Maint	I,II
Subchapter H - Schools and Other Certificated Agencies			
141	Pilot Schools	Ops	III

CFR Part #	Title	Primary Focus (Ops, Maint, Dsgn, Proc, Othr)	RLV O&M Review Phase
142	Training Centers	Ops, Maint	II
145	Repair Stations	Maint	I
147	Aviation Maintenance Technician Schools	Maint	I
Subchapter I - Airports			
150	Airport Noise Compatibility Planning	Ops	III
151	Federal Aid To Airports	Othr	III
152	Airport Aid Program	Othr	III
155	Release Of Airport Property From Surplus Property Disposal Restrictions	Othr	III
156	State Block Grant Pilot Program	Othr	III
157	Notice Of Construction, Alteration, Activation, And Deactivation Of Airports	Othr	III
158	Passenger Facility Charges (PFC's)	Othr	III
161	Notice And Approval Of Airport Noise And Access Restrictions	Othr	III
169	Expenditure Of Federal Funds For Nonmilitary Airports Or Air Navigation Facilities Thereon	Othr	III
Subchapter J - Navigational Facilities			
170	Establishment And Discontinuance Criteria For Air Traffic Control Services And Navigational Facilities	Ops	III
171	Non-Federal Navigation Facilities	Ops	III
Subchapter K - Administrative Regulations			
183	Representatives Of The Administrator	Maint	I
185	Testimony By Employees And Production Of Records In Legal Proceedings, And Service Of Legal Process And Pleadings	Othr	II
187	Fees	Othr	II
189	Use Of Federal Aviation Administration Communications System	Othr	III
193	Protection Of Voluntarily Submitted Information	Othr	II
Subchapter N - War Risk Insurance			

CFR Part #	Title	Primary Focus (Ops, Maint, Dsgn, Proc, Othr)	RLV O&M Review Phase
198	Aviation Insurance	Othr	III
Chapter II--Office Of The Secretary, Department Of Transportation (Aviation Proceedings)			
Subchapter A - Economic Regulations			
200	Definitions And Instructions	Othr	IV
201	Air Carrier Authority Under Subtitle Vii Of Title 49 Of The United States Code--[Amended]	Othr	IV
203	Waiver Of Warsaw Convention Liability Limits And Defenses	Othr	IV
204	Data To Support Fitness Determinations	Ops	IV
205	Aircraft Accident Liability Insurance	Ops	IV
206	Certificates Of Public Convenience And Necessity: Special Authorizations And Exemptions	Ops	IV
207	Charter Trips By U.S. Scheduled Air Carriers	Ops	IV
208	Charter Trips By U.S. Charter Air Carriers	Ops	IV
211	Applications For Permits To Foreign Air Carriers	Ops	IV
212	Charter Rules For U.S. And Foreign Direct Air Carriers	Ops	IV
213	Terms, Conditions And Limitations Of Foreign Air Carrier Permits	Ops	IV
214	Terms, Conditions, And Limitations Of Foreign Air Carrier Permits Authorizing Charter Transportation Only	Ops	IV
215	Use And Change Of Names Of Air Carriers, Foreign Air Carriers And Commuter Air Carriers	Ops	IV
216	Commingling Of Blind Sector Traffic By Foreign Air Carriers	Ops	IV
217	Reporting Traffic Statistics By Foreign Air Carriers In Civilian Scheduled, Charter, And Nonscheduled Services	Ops	IV
218	Lease By Foreign Air Carrier Or Other Foreign Person Of Aircraft With Crew	Ops	IV
221	Tariffs	Ops	IV

CFR Part #	Title	Primary Focus (Ops, Maint, Dsgn, Proc, Othr)	RLV O&M Review Phase
222	Intermodal Cargo Services By Foreign Air Carriers	Ops	IV
223	Free And Reduced-Rate Transportation	Ops	IV
232	Transportation Of Mail, Review Of Orders Of Postmaster General	Ops	IV
234	Airline Service Quality Performance Reports	Ops	IV
240	Inspection Of Accounts And Property	Ops	IV
241	Uniform System Of Accounts And Reports For Large Certificated Air Carriers	Ops	IV
243	Passenger Manifest Information	Ops	IV
247	Direct Airport-To-Airport Mileage Records	Ops	IV
248	Submission Of Audit Reports	Ops	IV
249	Preservation Of Air Carrier Records	Ops	IV
250	Oversales	Ops	IV
252	Smoking Aboard Aircraft	Ops	IV
253	Notice Of Terms Of Contract Of Carriage	Ops	IV
254	Domestic Baggage Liability	Ops	IV
255	Carrier-Owned Computer Reservations Systems	Ops	IV
256	Display Of Joint Operations In Carrier-Owned Computer Reservations Systems	Ops	IV
257	Disclosure Of Code-Sharing Arrangements And Long-Term Wet Leases	Ops	IV
258	Disclosure Of Change-Of-Gauge Services	Ops	IV
271	Guidelines For Subsidizing Air Carriers Providing Essential Air Transportation	Ops	IV
272	Essential Air Service To The Freely Associated States	Ops	IV
291	Cargo Operations In Interstate Air Transportation	Ops	IV
292	International Cargo Transportation	Ops	IV
293	International Passenger Transportation	Ops	IV
294	Canadian Charter Air Taxi Operators	Ops	IV
296	Indirect Air Transportation Of Property	Ops	IV

CFR Part #	Title	Primary Focus (Ops, Maint, Dsgn, Proc, Othr)	RLV O&M Review Phase
297	Foreign Air Freight Forwarders And Foreign Cooperative Shippers Associations	Ops	IV
298	Exemptions For Air Taxi And Commuter Air Carrier Operations	Ops	IV
Subchapter B - Procedural Regulations			
300	Rules Of Conduct In DOT Proceedings Under This Chapter	Proc	IV
302	Rules Of Practice In Proceedings	Proc	IV
303	Review Of Air Carrier Agreements	Proc	IV
305	Rules Of Practice In Informal Nonpublic Investigations	Proc	IV
313	Implementation Of The Energy Policy And Conservation Act	Proc	IV
314	Employee Protection Program	Proc	IV
323	Terminations, Suspensions, And Reductions Of Service	Proc	IV
325	Essential Air Service Procedures	Proc	IV
330	Procedures For Compensation Of Air Carriers	Proc	IV
Subchapter D - Special Regulations			
372	Overseas Military Personnel Charters	Othr	IV
374	Implementation Of The Consumer Credit Protection Act With Respect To Air Carriers And Foreign Air Carriers	Othr	IV
374a	Extension Of Credit By Airlines To Federal Political Candidates	Othr	IV
375	Navigation Of Foreign Civil Aircraft Within The United States	Ops	IV
377	Continuance Of Expired Authorizations By Operation Of Law Pending Final Determination Of Applications For Renewal Thereof	Ops	IV
380	Public Charters	Ops	IV
381	Special Event Tours	Ops	I
382	Nondiscrimination On The Basis Of Disability In Air Travel	Ops	IV
383	Civil Penalties	Ops, Maint	I
Subchapter E - Organization			

CFR Part #	Title	Primary Focus (Ops, Maint, Dsgn, Proc, Othr)	RLV O&M Review Phase
385	Staff Assignments And Review Of Action Under Assignments	Proc	IV
389	Fees And Charges For Special Services	Proc	IV
Subchapter F - Policy Statements			
398	Guidelines For Individual Determinations Of Basic Essential Air Service	Proc	IV
399	Statements Of General Policy	Proc	IV
Chapter III--Commercial Space Transportation, Federal Aviation Administration, Department Of Transportation			
Subchapter A - General			
400	Basis And Scope	Proc	I
401	Organization And Definitions	Proc	I
Subchapter B - Procedure			
404	Regulation And Licensing Requirements	Ops, Maint	I
405	Investigations And Enforcement	Proc	I
406	Investigations, Enforcement, And Administrative Review	Proc	I
Subchapter C - Licensing			
413	License Application Procedures	Proc	I
415	Launch License	Ops, Maint	I
420	License To Operate A Launch Site	Ops, Maint	I
431	Launch And Reentry Of A Reusable Launch Vehicle	Ops, Maint	I
433	License To Operate A Reentry Site	Ops, Maint	I
435	Reentry Of A Reentry Vehicle Other Than A Reusable Launch Vehicle (RLV)	Ops, Maint	I
440	Financial Responsibility	Ops, Maint	I
450	Financial Responsibility	Ops, Maint	I

14 CFR 61 Certification: Pilots, Flight Instructors, and Ground Instructors

Effective Date	10/18/2002
Contents and review purpose	This FAR contains the rules for issuing pilot, flight instructor, and ground instructor certificates or authorizations along with the privileges/limitations of any such certificates of authorizations. This FAR was reviewed to determine the types of considerations that may be relevant in issuing RLV pilot and instructor approvals.

Section	Title	Summary of Part	Notes/RLV Questions
SFAR 73	Robinson R-22/R-44 Special Training and Experience Requirements	Additional requirements for operators of Robinson R-22/R-44 helicopters Note: SFAR expires 12/31/02	Not relevant – might be interesting to understand what was unique about this design that required an SFAR
SFAR 93	Temporary Extension of Time To Allow for Certain Training and Testing	Provided a one-month extension for certain qualification as a result of the impact of September 11 events and the subsequent closure of the NAS. Note: SFAR expired 11/30/2001	Not relevant – provides example of an emergency SFAR
SFAR 96	Relief for Participants in Operation Enduring Freedom	Provides allowances for accepting expired piloting credentials provided the reason for the expiration was as a result of serving in Operation Enduring Freedom following September 11, 2001. Note: SFAR expires 5/6/2004	Not relevant – provides example of wartime exception
Subpart A – General			
61.1	Applicability and Definitions	States the overall topic of the FAR and provides the following definitions: aeronautical experience, authorized instructor, cross-country time, examiner,	There are some interesting issues raised in this set of definitions. For example, currency requirements are based on logged time. For

Section	Title	Summary of Part	Notes/RLV Questions
		flight simulator, flight training, flight training device, ground training, instrument approach, instrument training, knowledge test, pilot time, practical test, set of aircraft, training time,	RLVs, will this time need to be separated into atmospheric and exo-atmospheric time? The distances for establishing cross-country time would also seem to be questionable when providing credit for RLV flights – the distances are currently 25 and 50 nautical miles. Perhaps altitude should be included when capturing experience gained data. A number of the definitions also have the problem of airplane, airman, etc.
61.3	Requirement for Certificates, Ratings, and Authorizations	Lengthy enumeration of privileges and limitations associated with pilot, flight instructor, and ground instructor approvals. Disallows piloting without appropriate approvals including pertinent ratings (e.g. VFR, IFR, etc.), as well as medical certifications. Also includes the controversial age limitation. Finally, notes that all pilot and instructor credentials must be available for inspection by the FAA, the NTSB, or other law enforcement if requested.	Will need to be looked at in detail for RLV operations. Expect, at the very least, that there will be a new category of pilot defined that specifies necessary training for exo-atmospheric flight. It is unlikely that any additional stipulations would be required.
61.4	Qualification and Approval of Flight Simulators and Flight Training Devices	Basic requirement for flight simulator and flight training device qualification by the FAA. Broad latitude afforded to the FAA in approving devices other than those originally intended as such a device.	This is a fairly well written paragraph that states a requirement in broad terms without drawing in any specific technical design. It may be useful to use this as a model for the NPRM effort.

Section	Title	Summary of Part	Notes/RLV Questions
61.5	Certificates and Ratings Issued Under This Part	This section enumerates all of the different approvals and ratings issued by the FAA under this part. This includes types of pilots, instructors, aircraft, and capabilities.	Like 14 CFR 33, the format of this FAR is such that it may be possible to make minor changes to this FAR to incorporate RLV unique items without having to go the route of a 14 CFR 461.
61.7	Obsolete Certificates and Ratings	Only free-air balloon ratings issued prior to 11/1/73 are considered obsolete. There is also a note that indicates a rating must accompany a pilot's license for rotorcraft, lighter-than-air, helicopters and autogyros for the license to be valid.	N/A for RLVs - This is an interesting paragraph since rotorcraft is usually defined as either helicopters or autogyros. There separate callouts here is confusing.
61.9	[Reserved]	N/A	N/A
61.11	Expired Pilot Certificates and Reissuance	States that pilots cannot fly on an expired license. Enumerates a number of obsolete pilot's licenses, most issued before June of 1945. Actually seems to be contradictory to 61.7 for lighter than air licenses since it allows for reissuance of licenses granted prior to 6/30/45 with no expiration date.	Only the first item within this section would seem to be relevant for RLVs – it states the obvious: no license, no launch.
61.13	Issuance of Airman Certificates, Ratings, and Authorizations	Establishes the mechanism and grounds by which an airman certificate, rating, or authorization would be granted by the FAA. Includes details on the granting of approvals to foreign pilots; the recording of any physical limitations (requires they not create a safety problem); stipulates additional requirements for Cat II and Cat	All pretty straightforward requirements. Would think that such requirements should be in place for RLV pilots and instructors.

Section	Title	Summary of Part	Notes/RLV Questions
		III approvals; and, states a pilot cannot reapply during a suspension and instructors must wait a year following a revocation to reapply.	
61.14	Refusal to Submit to a Drug or Alcohol Test	Specifically limited to part 121 and part 135 licenses and approvals. Refuse to submit and you forfeit right to apply. Are also then subject to revocation or suspension of any previously granted approval.	If a separate “461” is written, similar stipulation for RLVs would need to be written.
61.15	Offenses Involving Alcohol or Drugs	States that if anyone who holds an approval under this part (includes pilots and instructors) is convicted for any offense involving drugs or alcohol, their approval is subject to suspension or revocation. Provides specific definitions as they relate to driving incidents and has a requirement for reporting any such convictions to the FAA.	If a separate “461” is written, similar stipulation for RLVs would need to be written.
61.16	Refusal to Submit to an Alcohol Test or To Furnish Test Results	Refuse to submit and you forfeit right to apply. Are also then subject to revocation or suspension of any previously granted approval.	If a separate “461” is written, similar stipulation for RLVs would need to be written.
61.17	Temporary Certificate	Allows for the issuance of a 120-day temporary certificate when qualifications of this part are met. Such temporary approvals expire once their expiration date is reached, a permanent certificate is issued, or it is revoked presumably whichever one comes first).	OK

Section	Title	Summary of Part	Notes/RLV Questions
61.19	Duration of Pilot and Instructor Certificates	States that a holder of any certificate awarded under this part cannot exercise the privileges after the expiration date and must return any suspended or revoked certificate to the FAA. Also notes specific durations (24 months) for students and instructor approvals unless renewed.	OK
61.21	Duration of a Category II and a Category III Authorization (for other than part 121 and part 135 use)	Category II and III pilot authorizations expire six months after month of issuance unless renewed. Such approvals will not be renewed beyond twelve months without a successful practical test. Cat II and III approvals are airplane type specific.	OK –doubtful that there will need to be Cat II and III approvals for RLV pilots in the near term.
61.23	Medical Certificates: Requirement and Duration	Outlines the different types of medical certificates (classes) for various activities along with their durations for pilots, instructors, AND air traffic control tower operators.	Will need to determine the appropriate medical classifications and certifications for RLV pilots and instructors. The information concerning ATC tower operators is out of place and seemingly out of scope given the earlier statement regarding applicability.
61.25	Change of Name	Outlines the documents required for processing a name change and stipulates the return of those documents after inspection.	OK
61.27	Voluntary Surrender or Exchange of Certificate	Outlines the process for permanent surrender or request for removal of certain approvals. Requires specific language in request acknowledging that to get back whatever approval is being	OK

Section	Title	Summary of Part	Notes/RLV Questions
		surrendered, a new approval will be required.	
61.29	Replacement of a Lost or Destroyed Airman or Medical Certificate or Knowledge Test Report	States who to transmit a request for replacement to along with what information must be provided. Also notes that there may be fees involved.	OK
61.31	Type Rating Requirements, Additional Training, and Authorization Requirements	States that pilots must be rated for particular types of aircraft along with their basic pilot's license. Allows for a small number of exceptions (e.g. ferry flights limited to certain operating modes or altitudes) in which a pilot may fly airplanes outside their rating. Identifies specific rating categories such as high-performance aircraft, high-altitude aircraft, complex aircraft, aircraft with tailwheels, and gliders.	General approach appears reasonable, but the categories are not relevant to most RLV concepts.
61.33	Tests: General Procedures	Testing required by this part is to be conducted at times and places designated by the FAA.	Do not understand the rationale behind this requirement. Approved training schools do not coordinate all of their test locations and times with someone in the FAA. Likewise, instructors are given wide latitude as to when they take students out for check flights, taxi tests, etc.

Section	Title	Summary of Part	Notes/RLV Questions
61.35	Knowledge Test: Prerequisites and Passing Grades	Specifies that a student must have an endorsement from an instructor that he/she is ready to take the knowledge test. Also notes the other information that must be provided at the time the test is accomplished (e.g. forms of ID). Finally, it stipulates that what constitutes a passing grade is determined by the FAA>	OK
61.37	Knowledge Tests: Cheating or Other Unauthorized Conduct	Enumerates all of the actions that are considered cheating.	OK
61.39	Prerequisites for Practical Tests	Enumerates the requirements for taking the practical test including prior successful completion of a knowledge test within the preceding 60 days. Other requirements include a minimum amount of aeronautical experience, at least a third-class medical certificate, and so much logged practice time. Certain allowances are made for active transport pilots and military pilots. There is also a time limitation between when you begin a practical test and when you successfully pass all elements of the test.	Need to really think through what is necessary for RLVs. This is OK as written, but brings in the entire supporting training infrastructure. This may not be necessary, particularly initially.
61.41	Flight Training Received from Flight Instructors not Certificated by the FAA	Allows credit for training by US military pilots, other military pilots of ICAO contracting states, or flight instructors of ICAO contracting states.	Not sure the extension to foreign pilots is appropriate – have not identified a model outside the US for RLV flight training.

Section	Title	Summary of Part	Notes/RLV Questions
61.43	Practical Tests: General Procedures	Identifies those items that must be accomplished to successfully complete a practical exam. Also outlines the reasons why a practical test might be stopped and what needs to be done to get credit for the test items passed before the overall exam was halted.	Wording in this paragraph is a good example for the high-level RLV rule. It uses terms like demonstrated sound judgment, satisfactory competency and proficiency, and mastery.
61.45	Practical Tests: Required Aircraft and Equipment	Stipulates the requirements to provide an appropriately certified aircraft for the conduct of the test. For IFR test, must also provide appropriate blinder to eliminate visual reference outside aircraft.	It will be difficult to meet the requirements for provision of craft for an RLV for repeated testing of the nature discussed here. Expect testing to make greater reliance on flight training devices.
61.47	Status of an Examiner Who is Authorized by the Administrator to Conduct Practical Tests	Examiner represents the Administrator when conducting tests and does not serve in the capacity of Pilot in Charge unless agreed upon either the applicant or the designated Pilot in Charge. Also contains a waiver to the requirements/limitations on carriage of passengers.	OK – unclear as to the rationale behind the waiver paragraph. Waiver may be to assert the element of risk in carriage of passengers during such a test.
61.49	Retesting After Failure	Retesting is done only when the applicant has received necessary training, and can demonstrate satisfactory instructional proficiency.	The elements noted in the summary namely stall awareness, spin entry, spins and recovery are those characteristics of the aircraft that can result in pilot not being able to control the airplane. There may be additional elements to be added to this list for RLVs depending upon the specific flight profile.

Section	Title	Summary of Part	Notes/RLV Questions
61.51	Pilot Logbooks	Details of flight and flight training are recorded for the purposes of judging whether the training was adequate, whether the training was conducted on an authorized flight simulator, or a flight training device, whether enough number of flight hours were logged for specific experience (student, instructor, instrument rating etc).	Safety precaution and a monitoring tool; applicable to RLVs.
61.53	Prohibition on Operations During Medical Deficiency	Even with a medical certificate, if during operations certain medical deficiencies or need for medicines violate that medical certificate, then the person is not allowed to operate as a pilot in command or in any other capacity as a required pilot flight crewmember.	Applicable to RLVs; this is equivalent of "continued airworthiness" for the pilot and crewmembers.
61.55	Second In-Command Qualifications	Qualifications for second in command.	Are there RLVs that are proposing a multi-pilot configuration? This item feeds into calculation of safety and risk, and also into the argument of whether the safety of the RLV is a major contributor to the safety of public on the ground.
61.56	Flight Review	A review of the flight and rules of flight are required. Proficiency and currency of qualifications for the flight instructor are also required. Student pilot is exempt from certain reviews in lieu of qualifications required for solo flights.	Applicable to RLVs.

Section	Title	Summary of Part	Notes/RLV Questions
61.57	Recent Flight Experience	Flight experience of any person who may act as a pilot in command is discussed.	Applicable to RLVs.
61.58	Pilot in Command Proficiency Check: Operation of Aircraft Requiring more than One Pilot Flight Crew Member	Includes pilot in command proficiency as well as training for operations requiring more than one crew member.	Applicable to RLVs; may have additional requirements for proficiency.
61.59	Falsification, reproduction, or Alteration of Applications, Certificates, Logbooks, Reports, or Records	Basis for suspending or revoking certificate, rating or authorization held by that person.	Applicable to RLVs.
61.60	Change of Address	Notification to the FAA within 30 days of change of address.	Applicable to RLVs.
Subpart B – Aircraft Ratings and Pilot Authorizations			
61.61	Applicability	Additional aircraft ratings after the certificate is issued. Also discusses requirements and limitations of pilot authorizations.	Applicable to RLVs, although the structure of presentation of these rules do not necessarily need to be the same. All of the requirements

Section	Title	Summary of Part	Notes/RLV Questions
			for ratings and authorizations can be presented in one rule rather than being scattered in many rules.
61.63	Additional Aircraft Ratings) other than on an airline transport pilot certificate)	Additional training requirements (what training, how long, qualifications of the instructor, log book review etc) as well as what elements of pilot training requirements that are common do not need to be repeated (knowledge test that has already been passed)	Applicable to RLVs; the class distinction between RLVs has not been made. Once that has been determined, there may be additional qualifications that a pilot can undergo to add new ratings.
61.64	[Reserved]	N/A	N/A
61.65	Instrument Flight Ratings	Qualifications of a person who applies for an instrument rating include proficiency in English, ground training, knowledge test, log of operation, instructor approval, simulator or training device approval, weather related safety information gathering and decision making, crew resource management, as well as flight proficiency.	Applicable to RLVs. There may be additional items required for flight proficiency for an RLV as well as appropriate landing or takeoff expertise depending upon the specific RLV flight profile.
61.67	Category II Pilot Authorization Requirements	Requirements specific to the pilot as well as the aircraft in which the practical test is to be conducted.	Applicable to RLVs. It has not yet been decided if there will be a parallel to different categories for all RLVs or only for aircraft like RLVs or not for any RLVs. More information on the need can be drawn only after the research on

Section	Title	Summary of Part	Notes/RLV Questions
			generic functions and the specific types of RLVs.
61.68	Category III Pilot Authorization Requirements	Similar to 61.61 and specific to Cat III requirements.	See 61.67.
61.69	Glider Towing: Experience and Training Requirements	Requirements for a person to act as the pilot in command during the towing of a glider- pilot training, technique and procedures for safe towing.	Applicable to RLVs.
61.71	Graduates of an Approved Training Program Other than under this Part: Special Rules	Training programs under parts 141 and 142 are recognized. Only the practical test has to be passed within 60 days of graduation. A person may also apply for an airline transport pilot rating or type rating or both under this part under certain conditions.	These cross training programs will apply only if in the RLV domain we formulate different type certificates that cover different types of vehicles or different classes of operations. There may also be a cross training between aviation and RLVs. Such rules can be used to specify what an aircraft pilot would have to do to become certified to pilot an RLV.
61.73	Military Pilots of Former Military Pilots: Special Rules	Military training counts only for pilots who have not lost their flying status for lack of proficiency or disciplinary action involving aircraft operation. Proficiency and currency of skills are required.	Such considerations apply to RLV applications also. A pilot who has been trained as a military pilot should have specific training or practical skills to be eligible to pilot an RLV.

Section	Title	Summary of Part	Notes/RLV Questions
61.75	Private Pilot Certificate Issued on the Basis of a Foreign Pilot License	License issued by a state under ICAO is recognized by the U.S. and a new certificate may be issued under this section. Limitations of that foreign license apply to the U.S. license.	RLVs currently do not have an international agreements under ICAO for any of the regulations. It is envisioned that such recognition would help uniform rules and recognition of skills for RLV pilots.
61.77	Special Purpose Pilot Authorization: Operation of US Registered Civil Aircraft Leased by a Person who is not a US Citizen	Only one special purpose authorization good for no longer than 60 calendar months is issued at a time. All of the qualifications that are imposed on a U.S. pilot must be met. Limitations include those of the special purpose authorization, requirements of pilot license in country of flight, revoking/suspension of pilot license, compliance to medical requirements.	Applicable to RLVs.
Subpart C – Student Pilots			
61.81	Applicability	Issuance of student certificates, operating rules and limitations.	Applicable to RLVs.
61.83	Eligibility Requirements for Student Pilots	Age restrictions and English language proficiency.	Applicable to RLVs; since RLVs are expected to use the NAS and international air space where English is the official air traffic language of communications.
61.85	Application	Application details.	Applicable to RLVs.

Section	Title	Summary of Part	Notes/RLV Questions
61.87	Solo Requirements for Student Pilots	Satisfactory passing of knowledge requirements for aircraft flight, airspace rules and procedures.	For RLVs there are additional requirements on both knowledge and flight characteristics.
61.89	General Limitations	Students cannot be the pilots in command for passenger carrying or for hire or for compensation.	This rule is for the safety of passengers. For RLVs, is it acceptable to have the student as one of the pilots on a passenger carrying flight?
61.91	[Reserved]	N/A	
61.93	Solo Cross-Country Flight Requirements	For flights greater than 25 nautical miles from the airport from which the flight originated.	What would be a solo flight for an RLV? The flight profile should include all of the possibilities of flight maneuvers during that solo flight. This needs to be determined not only in terms of the flight distance; it should cover at least simulation of orbit entry and reentry.
61.95	Operations in Class B Airspace and At Airports Located Within Class B Airspace	Student pilot is not allowed to operate an aircraft in a solo flight in Class B airspace unless the student has received both ground and flight training on that Class B airspace and airport.	RLV spaceports and airspace need to be characterized according to traffic patterns or other criteria. Requirements for students for solo flights would then depend upon the need for knowledge in safety operating the RLV in that area. Where RLVs share the NAS, there is a need for

Section	Title	Summary of Part	Notes/RLV Questions
			RLV student pilots to learn the rules of both airspace and airport/alternate airport to qualify for solo flights.
Subpart D – Recreational Pilots			
61.96	Applicability and Eligibility Requirements: General	Training and knowledge depend upon the type that is sought. Aeronautical experience, ground school, log keeping, and practical test are needed.	RLV recreational pilots may not be required to qualify to the higher levels of safety if they will not be carrying passengers.
61.97	Aeronautical Knowledge	Only basics of aeronautical knowledge and safety of equipment are required. The requirements are not as rigorous as is needed for an airline pilot.	Applicable to RLVs.
61.98	Flight Proficiency	Procedures for various types of aircraft.	Applicable to RLVs
61.99	Aeronautical Experience	At least 30 hours of actual flight training are required to have been entered in the logbook. At least 3 hours of flight training in the aircraft of the same rating and at least 3 hours of solo flight experience are required.	The average flight of a recreational RLV flight needs to be calculated. This would be a logical flight duration to be used as a qualification requirement for solo flights. The same can be applied for duration of flight training.
61.100	Pilots Based on Small Islands	Considerations include flying over water for more than 10 nautical miles, and flights without flying over water to airports on the island. Limitations noted on a recreational pilot certificate will include appropriate limitations for carrying passengers.	Applicable to RLVs with appropriate changes, i.e., the pilot training and certificates should consider the usual flight path and allow for proper training. If full training is not always needed, partial training with appropriate

Section	Title	Summary of Part	Notes/RLV Questions
			limitations on the certificate should be considered.
61.101	Recreational Pilot Privileges and Limitations	Limitations on recreational pilots are to exclude the pilot from operating for pay, or carrying more than one passenger. A recreational pilot can fly no more than 50 nautical miles from the departure airport with all the associated training. If the recreational pilot were to fly more than 50 nautical miles, he/she should be proficient in cross-country flying and receive all the associated training. Requirements for the recreational pilot to assume pilot-n-command position are also specified.	Recreational pilot certificate has only a subset of requirements of a pilot certificate. The risks of each situation are considered in coming up with limitations of such a pilot. This is applicable to RLVs if there will be different classes of pilots. Some pilots may be certified for only a certain type of RLV and for a specific flight profile. Limitations may state that the pilot cannot operate for hire in certain other RLVs or certain other flight profiles.
Subpart E – Private Pilots			
61.102	Applicability	Requirements for private pilots and general operating rules.	Private pilots of RLVs may have a parallel in this subpart.
61.103	Eligibility Requirements: General	Age, English language proficiency, logbook endorsement of knowledge test, practical test, and flight training.	For different classes of RLVs the requirements may be different. The basic structure of what is needed holds for RLVs also.
61.105	Aeronautical Knowledge	Details of aeronautical knowledge areas.	For RLVs, a list of all of the applicable regulations, arrival and departure rules from spaceports (such as use of navigation

Section	Title	Summary of Part	Notes/RLV Questions
			systems, use of ground infrastructure, use of ATC) etc, applies.
61.107	Flight Proficiency	Proficiency at all stages of the flight.	This would depend upon the flight profile of the RLVs; the details of how these tasks are done will be different for different RLVs. The basic generic list for aviation can be used even though the technology and flight profile are different for RLVs.
61.109	Aeronautical Experience	The number of hours of different types of training required for different types of aircraft.	The training is commensurate with the usual flight profile of the type of aircraft. For RLVs, the flight profile should be set as a typical mission and the training should be geared towards all of the techniques needed in a nominal flight as well as any emergencies that may be encountered during such a flight.
61.110	Night Flying Exceptions	Applies only to pilot who receive their training in Alaska and who live in Alaska.	Not sure if such an exception is needed for RLVs.
61.111	Cross-Country Flights: Pilots Based on Small Islands	Location of the other airports and flight distance over water dictate the amount of training these pilots need to receive.	Training should be commensurate with flight profile and the class of the RLV.
61.113	Private Pilot Privileges and Limitations: Pilot in Command	Privileges and limitations in order to mitigate the risks of a private pilot taking on more responsibility than the training and experience can afford.	Applicable to RLVs in that the duties of a specific command should be considered in terms of whether the pilot has been trained for that specific set of skills.

Section	Title	Summary of Part	Notes/RLV Questions
61.115	Balloon Rating: limitations	Different levels of ratings and limitations.	Limitations should be considered for removal as the pilot accomplishes more skills or accumulates necessary experience.
61.117	Private Pilot Privileges and Limitations: Second in Command of Aircraft Requiring More Than One Pilot	Privileges and limitations to be second in command (references 61.113); prohibits the pilot to act as second in command for carrying passengers or property for compensation or hire.	Prohibit use of one kind of pilot license to be applied to services for which the license was not issued. Applicable to RLVs.
61.118-61.120	[Reserved]	N/A	N/A
Subpart F – Commercial Pilots			
61.121	Applicability	Requirements and operating rules for commercial pilot certificates.	Applicable to RLVs in following the broad reasoning behind issuance of such certificates.
61.123	Eligibility Requirements: General	Age and English language proficiency requirements, ability to provide evidence of ground school training, practical test, flight training.	Applicable to RLVs.
61.125	Aeronautical Knowledge	Knowledge areas are listed.	RLV knowledge areas will expand beyond this list to include space travel and specifics of the type of technology used in the type of RLV for which certificate is sought.
61.127	Flight Proficiency	Ability to handle normal and emergency situations in all phases of flight.	RLV pilots need training and proficiency in additional phases pertaining to space travel and

Section	Title	Summary of Part	Notes/RLV Questions
			specific types of technology used.
61.129	Aeronautical Experience	Specific number of hours of training and flight experience needed.	The number of hours of flight experience is dependent upon a nominal flight profile of the RLV; requirements for piloting that RLV should be commensurate with the experience needed for that nominal flight allowing contingencies for emergencies.
61.131	Exceptions to the Night Flying Requirements	Pertains only to persons receiving flight training in and residing in Alaska.	Exceptions to night flying requirements may not be needed for RLVs.
61.133	Commercial Private Pilot Privileges	Lists the privileges afforded to commercial private pilots. Includes endorsing of logbooks for student pilots.	RLV pilot privileges could include endorsing/supervising/training other pilots.
61.135 – 61.141	[Reserved]	N/A	N/A
Subpart G – Airline Transport Pilots			
61.151	Applicability	Requirements and operating rules for airline transport pilot certificates.	RLVs may not (at least initially) require this certification to be any different from the commercial pilot certificate.
61.153	Eligibility Requirements: General	Age (higher) and English language proficiency requirements, and be of "good moral character". Hold commercial pilot certificate and/or experience, and medical certificate.	Wordings such as "good moral character" should be avoided in RLV FARs. Such criteria cannot be objectively measured.
61.155	Aeronautical Knowledge	List of subjects required.	RLVs may require additional subjects specific to technology and space travel.

Section	Title	Summary of Part	Notes/RLV Questions
61.157	Flight Proficiency	Proficiency in procedures pertaining to all phases of flight.	RLVs require additional phases as well as technology specific items.
61.158	[Reserved]	N/A	N/A
61.159	Aeronautical Experience: Airplane Category Rating	Number of hours of experience needed in specific experiences.	RLVs need to assess the number of hours required for commercial pilots and consider whether a higher category of experience is needed for a "airline" pilot category.
61.161	Aeronautical Experience: Rotorcraft Category and Helicopter Class Rating	Number of hours of experience in specific experience for rotorcraft rating.	Rating can be specific to specific types of RLVs.
61.163	Aeronautical Experience: powered-lift Category Rating	Number of hours of experience in specific experience for powered-lift rating.	See comments on 61.161
61.165	Additional Aircraft Category and Class Ratings	Additional requirements for a person who holds an airline transport pilot certificate with another aircraft category rating.	See comments on 61.161
61.167	Privileges	Privileges are the same as a commercial pilot with instrument rating.	RLVs may or may not need this category of pilots separated from commercial pilots. Note that these pilots can be used to train other pilots, and endorse logbooks, although there is a limitation on the number of hours and CAT II and CAT III operations unless the pilot

Section	Title	Summary of Part	Notes/RLV Questions
			has been trained for these duties.
61.169 – 61.171	[Reserved]	N/A	N/A
Subpart H – Flight Instructors			
61.181	Applicability	Requirements and limitations of certificates and ratings.	For RLVs, specific requirements of aviation instructions should be made use of to the extent possible. Additional training that is needed by RLV pilots should be separated out and should be given by other eligible instructors.
61.183	Eligibility Requirements	Age, proficiency in English language, commercial pilot rating or airline transport rating with aircraft class and category rating that is appropriate to the flight instructions, instrument rating that is appropriate, having passed all of the areas that is to be taught to the student, teacher certificate.	RLV instructors should be required to know all of the subjects to be instructed as well as hold a teacher certificate. If aviation instructors are used, the other subjects may be taught by subject matter experts who have had practical experience in the type of technology that is being taught.
61.185	Aeronautical Knowledge	Knowing how to teach the subjects on the list.	Should be the same for RLVs.
61.187	Flight Proficiency	Proficiency in a list of subjects same as is on the pilot certificates.	The instructor should be proficient in the subjects that he is expected to teach.
61.189	Flight Instructor Records	Logbook endorsement. Producing evidence of the number of hours of training.	Should be required for RLVs.
61.191	Additional Flight Instructor	Requirements for applying for additional ratings. Only the skills that do not overlap	Should be the same for RLVs.

Section	Title	Summary of Part	Notes/RLV Questions
	Ratings	in the previously passed rating are required.	
61.193	Flight Instructor Privileges	Authorized to give training and endorsement for the class and category.	Should be the same for RLVs.
61.195	Flight Instructor Limitations and Qualifications	Limited hours of flight training, no training in an aircraft that is not in the rating class or category, limitations on endorsement of logbook.	Should be applicable to RLVs.
61.197	Renewal of Flight Instructor Certificates	Currency and knowledge of flight are required.	Should be applicable to RLVs.
61.199	Expired Flight Instructor Certificates and Ratings	Required to pass knowledge and practical test.	Should be applicable to RLVs.
61.201	[Reserved]	N/A	N/A
Subpart I – Ground Instructors			
61.211	Applicability	Ground instructor qualifications and limitations.	Applicable with extended knowledge qualifications appropriate for space travel and specific technologies used.
61.213	Eligibility Requirements	Age and English language proficiency, teaching skills/discipline.	Applicable to RLVs.
61.215	Ground Instructor Privileges	Provide ground training in specific area of expertise for which the trainer has the rating.	Applicable to RLVs.
61.217	Recent Experience Requirements	Currency requirements.	Applicable to RLVs- the actual number of months of experience within the last so many number of

Section	Title	Summary of Part	Notes/RLV Questions
			months may be specified as appropriate to the speed of RLV technological advancements.

14 CFR 63 Certification: Flight Crewmembers Other Than Pilots

Effective Date	10/18/02
Contents and review purpose	This part prescribes the requirements for issuing flight engineer and flight navigator certificates and the general operating rules for holders of those certificates. These rules were reviewed for applicability to RLVs.

Subpart A - General			
Section	**Title**	**Summary of Part**	**Notes/RLV Questions**
63.1	Applicability	Certification requirements and operating rules for flight engineers and flight navigators.	Applies to RLVs also. It is not clear if these will have only one pilot. However, the training for pilots, engineers and navigators for RLVs will include additional topics pertaining to space travel.
63.2	Certification of Foreign Flight Crewmembers other than Pilots	Foreign flight crew members other than pilots are certificated at the discretion of the Administrator.	Applicable to the RLVs
63.3	Certificates and Ratings Required	No person may perform these duties without a flight engineer certificate or a flight navigator certificate and at least a second-class medical certificate.	Applicable to RLVs.
63.11	Application and Issue	Application details.	Applicable to RLVs

63.12	Offenses Involving Alcohol or Drugs	Grounds for denial and suspension or revocation of certificate	Applicable to RLVs
63.112a	Refusal to Submit to an Alcohol Test or to Furnish Test Results	Refusal is also grounds for denial and suspension or revocation of certificate	Applicable to RLVs
63.12b	Refusal to Submit to a Drug or Alcohol Test	Refusal is also grounds for denial and suspension or revocation of certificate	Applicable to RLVs
63.13	Temporary Certificate	120-day certificate may be issued on a temporary basis pending review of application and other documents.	Applicable to RLVs
63.15	Duration of Certificate	Generally effective until surrendered.	Applicable to RLVs
63.15a	[Reserved}		

63.16	Change Name, Replacement of Lost or Destroyed Certificate	Change of name documents should accompany the certificate.	Applicable to RLVs
63.17	Tests: General Procedures	Time, places and administering requirements as designated by the Administrator. Passing grade is 70%.	Applicable to RLVs
63.18	Written Tests: Cheating or Other Unauthorized Conduct	Rules for taking the written tests.	Applicable to RLVs
63.19	Operations During Physical Deficiency	Should not operate under known physical deficiency.	Applicable to RLVs.
63.20	Applications, Certificates, Logbooks, Reports, and Records, Falsification, Reproduction, or Alteration.	No fraudulent or false entry in the application.	Applicable to RLVs

63.21	Change of Address	Should be reported within 30 days	Applicable to RLVs
63.23	Special Purpose Flight Engineer and Flight Navigator Certificates: Operation of U.S. registered Civil Airplanes Leased by a Person not a U.S. Citizen.	Special rules for issuing a flight engineer or flight navigator certificate to a holder of current foreign certificate issued by a ICAO state.	Applicable to RLVs. The rules may be different for RLVs; but the idea of allowing a flight engineer or a navigator from an ICAO state should be considered.
Subpart B - Flight Engineers			
63.31	Eligibility Requirements, General	Requirements	Applicable to RLVs
63.33	Aircraft Ratings	Ratings placed on the flight engineer's certificates	Applicable to RLVs; There is a need to determine if there are different classes or types of RLVs, what are these classes based on and whether the requirements will be the same for all flight crew within each of these classes.

63.35	Knowledge Requirements	Written test requirements.	The subjects may have to be expanded for RLVs. Current astronaut training guidelines should be reviewed to update the list for RLVs.
63.37	Aeronautical Experience Requirements	Experience requirements`	Applicable to RLVs with updated experience requirements as appropriate to the knowledge needed for space travel.
63.39	Skill Requirements	Practical test requirement that may be given an the same class of airplane for which the rating is sought.	Applicable to RLVs.
63.41	Retesting after Failure	Time lapse before retesting.	Applicable to RLVs
63.42	Flight Engineer Certificate Issued on Basis of a Foreign Flight Engineer License	Requirements for issuing a certificate based on a foreign certificate.	Applicable to RLVs.
63.43	Flight Engineer Courses	Course outline, facilities and equipment and a list of instructors and their qualifications, should be submitted.	Applicable to RLVs. Additional courses as required by space travel should be included.

Subpart C - Flight Navigators			
63.51	Eligibility Requirements, General	Requirements.	Applicable to RLVs
63.53	Knowledge Requirements	Requirements for the written test.	Should be expanded for RLVS to include topics needed for space travel.
63.55	Experience Requirements	Experience in similar type of aircraft.	Should be expanded for RLVs.
63.57	Skill Requirements	Skills needed for navigation are isolated and given as a practical test.	The test needs to be expanded for RLV specific skills.
63.59	Retesting after Failure	Required time laps before taking a test after failing one.	Applicable to RLVs.
63.61	Flight Navigator Courses	Course outline, facilities and equipment, instructors and qualification need to be submitted.	Applicable to RLVs; Curricula should include topics needed for space navigation.

Appendix A to Part 63	Test Requirements for Flight Navigator Certificate	Test requirements for Flight Navigator Certificate	Needs to be expanded for RLVs.
Appendix B to Part 63	Flight Navigator Training Course Requirements	Course requirements are listed.	Needs to be expanded for RLVs.
Appendix C to Part 63	Flight Engineer Training Course Requirements	Details of course requirements.	Course needs to be expanded for space travel.

14 CFR 67 Medical Standards and Certification

Effective Date	10/18/02
Contents and review purpose	This part prescribes rules for medical standards and certification procedures for issuing medical certificates for airmen and for maintaining eligibility. These rules were reviewed for applicability to RLVs.

Subpart A - General			
Section	Title	Summary of Part	Notes/RLV Questions
67.1	Applicability	Rules for medical standards, certification and maintenance of medical certificate.	Applicable to RLVs. There may be other medical requirements that are needed for space travel. NASA requirements for astronauts should be reviewed. Medical certificates may also be required for passengers, although these may not be as stringent as airman requirements.
67.3	Issue	Medical certificates are based on medical examination and evaluation of the person's history and condition.	Applicable to RLVs.
67.7	Access to the National Driver Register	Applicant gives consent to the administrator for accessing the National Driver Register.	Applicable to RLVs.
Subpart B - First Class Airman Medical Certificate			

67.101	Eligibility	Eligibility requirements are in this subpart.	Applicable to RLVs.
67.103	Eye	Vision acuity, range, field of view, color recognition for safe performance of duties. No pathological conditions or break in fusion that can affect airman duties.	Applicable to RLVs.
67.105	Ear, Nose, Throat, and Equilibrium	Acceptable hearing, no interference with communications, flying or equilibrium.	Applicable to RLVs
67.107	Mental	No disorders or substance dependence that would interfere with consistent performance of airman duties.	Applicable to RLVs.
67.109	Neurological	No neurological disorders that may interfere with consistent performance of airman duties.	Applicable to RLVs.
67.111	Cardiovascular	No known heart attack risk.	Applicable to RLVs.

67.113	General Medical Condition	No diabetes, no condition that may make the person unable to perform safety as an airman.	Applicable to RLVs.
67.115	Discretionary Issuance	If the person does not meet the requirements in subpart B, then th person may apply for a discretionary issuance under 67.401.	May or may not be applicable to RLVs depending upon whether multiple pilots are allowed in the cockpit. If there is only one pilot, the FAA may insist that they be certified to highest standards to reduce risk.
Subpart C - Second-Class Airman Medical Certificate			
67.201	Eligibility		May not be applicable to RLVs; see 67.115.
67.203	Eye		May not be applicable to RLVs; see 67.115.
67.205	Ear, Nose, Throat, and Equilibrium		May not be applicable to RLVs; see 67.115.

67.207	Mental		May not be applicable to RLVs; see 67.115.
67.209	Neurologic		May not be applicable to RLVs; see 67.115.
67.111	Cardiovascular		May not be applicable to RLVs; see 67.115.
67.213	General Medical Condition		May not be applicable to RLVs; see 67.115.
67.215	Discretionary Issuance		May not be applicable to RLVs; see 67.115.
Subpart D - Third-Class Airman Medical Certificate			
67.301	Eligibility		May not be applicable to RLVs; see 67.115.

67.303	Eye		May not be applicable to RLVs; see 67.115.
67.305	Ear, Nose, Throat, and Equilibrium		May not be applicable to RLVs; see 67.115.
67.307	Mental		May not be applicable to RLVs; see 67.115.
67.309	Neurologic		May not be applicable to RLVs; see 67.115.
67.311	Cardiovascular		May not be applicable to RLVs; see 67.115.
67.313	General Medical Condition		May not be applicable to RLVs; see 67.115.

67.315	Discretionary Issuance		May not be applicable to RLVs; see 67.115.
Subpart E - Certification Procedures			
67.401	Special Issuance of Medical Certificate	Special considerations when the person does not meet the requirements for a specific class.	May not be applicable to RLVs; see 67.115.
67.403	Application, certificates, logbooks, reports, and records; Falsification, reproduction, or alteration, incorrect statements	Application requirements and supporting information.	Applicable to RLVs.
67.405	Medical Examinations: who may give	Aviation medical examiner may give the examination.	Applicable to RLVs.
67.407	Delegation of Authority	Administrator has delegate the authority to issue or deny the medical certificate to Federal Air Surgeon under 49 U.S.C. 44703.	Applicable to RLVs.

67.409	Denial of Medical Certificate	Medical examiner does not have the final say in denial of medical certificate- this decision may be reversed by the Federal Air Surgeon, the Manager, Aero medical Certification Division; or a Regional Flight Surgeon.	Applicable to RLVs.
67.411	Medical Certificates by Flight Surgeons of Armed Forces	Flight Surgeons of the Armed Forces on specified military posts, station, and facilities have been designated by the FAA to be aviation medical examiners.	Applicable to RLVs.
67.413	Medical Records	The applicant has to provide or authorize release of medical information or history as is necessary to determine whether an applicant for or the holder of medical certificate meets the medical standards.	Applicable to RLVs.
67.415	Return of Medical Certificate after suspension or revocation	Medical certificate should be returned to the Administrator when the certificate is revoked.	Applicable to RLVs.

14 CFR 73 Special Use Airspace

Effective Date	10/18/02
Contents and review purpose	This part specifies rules for Special Use Airspace. This review is to examine use of Special Use Airspace (SUA) for RLVs as with other launches, and also to explore whether other procedures may be suitable for routine RLV operations with minimum disruptions to the NAS.

Subpart A - General			
Section	Title	Summary of Part	Notes/RLV Questions
73.1	Applicability	Subpart B and C define Special Use Airspace (SUA).	RLV operations may need new definitions of a different kind of SUA especially if RLV traffic is to be integrated into the NAS.
73.3	Special Use Airspace	Consists of airspace above defined dimensions of an area on the surface of the earth. Altitude floors and ceilings are defined. There is also a definition of period of time through which SUA is in effect.	
73.5	Bearings, Radials, Miles	True bearing and radial and statute miles are used in the definition of SUA.	
Subpart B - Restricted Areas			
73.11	Applicability	Prescribes limitations on the operation of aircraft within restricted areas.	

73.13	Restrictions	Cannot operate aircraft in restricted area without advance permission as in 73.15 or 73.17.	In the case of RLV regulations who will be in charge of SUAs? Will RLV SUAs be the same as the NAS SUAs? If so, the controlling agency is the FAA. The using agency will be FAA AST. Ruling by AST may not include military launches. Those restricted areas will be worked out between the military and the FAA.
73.15	Using Agency	Agency whose activity within a restricted area necessitated the area to be so designated. Make sure that all activities are in accordance with the designated purpose, within the time allotted and within the restricted area. Using agency executes a letter establishing joint use of the restricted area by the using agency and the controlling agency in accordance with the terms of the letter.	It is not clear how RLV traffic which takes off from an airport can be directed to an SUA unless the airport is declared to be an SUA also for the purposes of launch.
73.17	Controlling Agency	For this part, the FAA is the controlling agency that may authorize transit through the restricted area per a joint-use letter as in 73.15.	
73.19	Reports by Using Agency	Using agencies are required to prepare a report on use of restricted area for the 12-month period ending in September 30. The report should be transmitted to the FAA by January 31 of the following year. Details of the contents of the report are specified.	
Subpart C - Prohibited Areas			

73.81	Applicability	This part applies to prohibited areas and their limitations on the operation of aircraft within these areas.	
73.83	Restrictions	No one may operate within this area unless authorization has been granted by the using agency.	This rule specifically states operation of an "aircraft" within this area. Perhaps the rules should be more general and specify use of this airspace for any purpose, thus avoiding specification of the type of vehicle that should not be operated.
73.85	Using Agency	Organization or military using this area.	

14 CFR 93 Special Air Traffic Rules and Airport Traffic Patterns

Effective Date	10/18/02
Contents and review purpose	These procedures specify special airport traffic patterns and airport traffic areas. This text was reviewed to assess applicability and sufficiency of these requirements for RLVs.

Subpart A - General			
Section	Title	Summary of Part	Notes/RLV Questions
93.1	Applicability	Specifies special traffic rules and patterns for certain airports; includes air traffic rules for aircraft being operated in the vicinity of the airports discussed in this part.	In general, would not expect any of this FAR to come into play for most RLV flights. They may be applicable to RLVs if these airports are used as a primary or backup spaceport.
Subpart B - {Reserved}			
Subpart C - {Reserved}			
Subpart D - Anchorage, Alaska, Terminal Area			
93.51	Applicability	Prescribes special traffic rules and patterns for Anchorage, Alaska Terminal Area	RLVs will have to comply with the existing rules for particular airports and existing traffic patterns in any given area. Rules for primary spaceports as well as emergency landing sites should be familiar to the RLV pilots. It is not clear whether new and accurate navigation aids would change the patterns to help a more efficient use of airspace. The air traffic rules are also based on air traffic controller tools and workload which are limited.

93.53	Description of Area	Physical location specified by way of latitude/longitude and streets surrounding the airport.	
93.55	Subdivision of Terminal Area	Divides the surrounding airspace into a series of segments.	
93.57	General Rules: All Segments	Calls out a series of paragraphs of this FAR that apply to all segments. Requires two-way communications with ATCT.	
93.59	General Rules: International Segment	Imposes altitude and airspeed restrictions.	
93.61	General Rules: Lake Hood Segment	Imposes altitude and airspeed restrictions.	
93.63	General Rules: Merrill Segment	Imposes altitude and airspeed restrictions.	

93.65	General Rules; Elmendorf Segment	Imposes altitude and airspeed restrictions.	
93.67	General Rules: Bryant Segment	Imposes altitude and airspeed restrictions.	
93.68	General Rules: Seward Highway Segment	Imposes altitude and airspeed restrictions.	
93.69	Special Requirements, Lake Campbell and Sixmile Lake Airports	Imposes directional flow control in accordance with appropriate aeronautical charts.	
Subpart E - {Reserved}			
Subpart F - Valparaiso, Florida, Terminal Area			
93.81	Applicability and Description of Area	Lat/Long description of overall area and segments.	

93.83	Aircraft Operations	Limitations on operation unless two-way communication established with Eglin Radar Control Facility.	
Subpart G-I - {Reserved}			
Subpart J - Lorain County Regional Airport Traffic Rule			
93.117	Applicability	Special rule for airport in Lorain County, OH.	
93.119	Aircraft Operations	Limitations on takeoff and landing patterns.	
Subpart K - High Density Traffic Airports			
93.121	Applicability	Designates high density airports and prescribes air traffic rules for operating aircraft other than helicopters to and from these airports.	
93.123	High Density Traffic Airports	Lists high-density airports including Washington National, O'Hare, JFK, LaGuardia, and Newark. [This FAR section dates to 1973 and is not inclusive of many major airports of today (e.g. LAX, Atlanta Hartsfield, and Boston Logan).	
93.125	Arrival or Departure Reservation	Restricts flight operations to IFR only outside of 12 midnight to 6 am at high density airports.	

93.129	Additional Operations	Allows for operations provided ATC has provided the appropriate departure or arrival reservation. Includes specific definition for "scheduled operation to or from high density airport"	
93.130	Suspension of Allocations	Gives the Administrator broad authority in suspending allocations at high-density airports if necessary to make efficient use of airspace.	
93.133	Exceptions	Makes certain exceptions for Newark, JFK, and O'Hare at certain times.	
Subpart L - [Reserved]			
Subpart M - Ketchikan International Airport Traffic Rule			
93.151	Applicability	Specifies certain rules for Ketchikan Airport.	
93.153	Communications	Requires two-way operations with the Ketchikan Flight Service Station whenever it is in operation for both surface and air terminal movement. When the FSS is not in operation, requires monitoring of the Common Traffic Advisory Frequency (CTAF).	
93.155	Aircraft Operations	Imposes certain flight restrictions and coordination with ATC when available.	
Subpart N-R - [Reserved]			
Subpart S - Allocation of Commuter and Air Carrier IFR Operations at High Density Traffic Airports			

93.211	Applicability	Certain airports designated as high-density airports are subject to restrictions in the number of certain types of traffic per hour.	RLVs may not be allowed to operate in or close to high-density traffic airports because of the special attention needed for RLV takeoff/landing (at least initially). Sharing of terminal airspace for takeoff and landing is managed using a slot system to be equitable to the users.
93.213	Definitions and General Provisions	Provides definitions of "new entrant carrier", "slot", "summer season", "winter season", and "limited incumbent carrier"	
93.215	Initial Allocation of Slots	Allocation at high-density airports (excluding Newark) as of December 16, 1985.	Not applicable to RLVs
93.217	Allocation of Slots for International Operations and Applicable Limitations	Slot allocation rules	Not applicable to RLVs
93.218	Slots for Transborder Service To and From Canada	Slot allocation rules	Not applicable to RLVs
93.219	Allocation of Slots for Essential Air Service Operations and	Slot allocation rules	

	Applicable Limitations		
93.221	Transfer of Slots	Slot allocation rules	
93.223	Slot Withdrawal	Slot allocation rules	
93.224	Return of Sots	Slot allocation rules	
93.225	Lottery of Available Slots	Slot allocation rules	
93.226	Allocation of Slots in Low-Demand Periods	Slot allocation rules	
93.227	Slot Use and Loss	Slot allocation rules	
Subpart T - Washington National Airport Traffic Rules			

93.251	Applicability	Special rule for Washington National.	
93.253	Nonstop Operations	Preclusion of non-stop service for any destination greater than 1250 miles for Washington National.	
Subpart U - Special Flight Rules in the Vicinity of Grand Canyon National Park, AZ			
93.301	Applicability	All aircraft operations in the Grand Canyon National Park Special Flight Rules Area - specified by lat/long.	
93.303	Definitions	Provides definitions for "allocation", "commercial air tour", "commercial special flight rules area", "flight standards district office", "park", and "special flight rules area"	
93.305	Flight-free zones and Flight Corridors	Flight-free zones and flight corridors specified by lat/long.	
93.307	Minimum Flight Altitudes	Specified by type of flight and by corridor. Lowest altitude in all restrictions is 5000 feet.	
93.309	General Operating Procedures	Operating rules for Grand Canyon	

93.311	Minimum Terrain Clearance	Operating rules for Grand Canyon	
93.313	Communications	Operating rules for Grand Canyon	
93.315	Requirements for Commercial Special Flight Rules Area Operations	Operating rules for Grand Canyon	
93.316	[Reserved]		
93.317	Commercial Special Flight Rules Area Operation Curfew	Operating rules for Grand Canyon	
93.319	Commercial Air Tour Limitations	Operating rules for Grand Canyon	
93.321	Transfer and Termination of Allocations	Operating rules for Grand Canyon	

93.323	Flight Plans	Operating rules for Grand Canyon	
93.325	Quarterly Reporting	Operating rules for Grand Canyon	
Appendix to Subpart U	Special Flight Rules in the Vicinity of Grand Canyon National Park, AZ	Operating rules for Grand Canyon	

14 CFR 95 IFR Altitudes

Effective Date	10/18/02
Contents and review purpose	This part specifies rules for IFR altitudes. This review is to examine if instrumental flight rules need to be different for RLVs.

Subpart A - General			
Section	Title	Summary of Part	Notes/RLV Questions
95.1	Applicability	This part prescribes altitudes governing the operation of aircraft under Instrumental Flight Rules on Federal airways, jet routes, area navigation low or high routes, or other direct routes for which a MEA is designated in this part. This part also designates mountainous areas and changeover points. Other abbreviations that appear to be altitude designations are stated in this part.	A clear definition of terms such as MEA, MAA, MOCA, MCA and MRA would be helpful if a similar rule is written for RLVs.
95.3	Symbols	Some of the acronyms used are expanded.	
Subpart B - Designated Mountainous Areas			
95.11	General	The areas in this subpart are designated mountainous areas.	This specification may be generalized if GPS mapping is consistently used by all RLVs - specification of mountainous area may be in terms of rate of change of terrain change or altitude instead of specific lat-long.

95.13	Eastern United States Mountainous Area	Has a map and boundary specification to designate the area.	
95.15	Western United States Mountainous Area	Has a map and boundary specification to designate the area.	
95.17	Alaska Mountainous Area	Has a map and boundary specification to designate the area.	
95.19	Hawaii Mountainous Area	Has a map and boundary specification to designate the area.	
95.21	Puerto Rico Mountainous Area	Has a map and boundary specification to designate the area.	
Subpart C - En Route IFR Altitudes Over Particular Routes and Intersections			
95.31	General	Prescribes IFR altitudes for flights along particular routes or route segments and over additional intersections not listed as a part of a route or route segment.	
Subpart D - Changeover Points			
95.8001	General	Prescribes changeover points for Federal airways, jet routes, area navigation routes or other direct routes for which an MEA is designated in this part.	An aircraft has clear waypoints or navigational facilities or intersection of radials or courses. What would be equivalent to changeover points for an RLV?

14 CFR 97 Standard Instrument Approach Procedures

Effective Date	10/18/02
Contents and review purpose	These procedures specify requirements for instrument approach procedures for instruments and weather requirements at the airports. This text was reviewed to assess applicability and sufficiency of these requirements for RLVs.

Subpart A - General			
Section	Title	Summary of Part	Notes/RLV Questions
97.1	Applicability	Specifies standard instrument approach procedures and weather minima.	Applicable to RLVs.
97.3	Symbols and terms used in procedures	Has categories of landing, approach procedure segments, and abbreviations	These symbols and terms may have to be updated for RLVs. For example, for RLVs there will be a discussion of alternate spaceports in addition to alternate air ports. The approach procedure segments may be different for RLVs. Categories of landing may also have to be redefined depending upon the type of landing of specific RLVs.
97.5	Bearings, courses, headings, radials, miles	Units of measurements are specified.	We may need to define other parameters and units depending upon the conventional use for description of RLV flight profiles.
Subpart B - Procedures			

97.10	General	Prescribes standard instrument approach procedures other than those based on the U.S. Standard for Terminal Instrument Approach Procedures adopted by the FAA.	
Editor's Note		The procedures were transferred to part 97.11 through 97.19 but not carried in CFRs.	Charts prepared for the use of pilots by the U.S. Coast and Geodetic Survey and other publishers of aeronautical charts do use these standard instrument approach procedures.
Subpart C - Terps Procedures			
97.20	General	Prescribes Terminal Instrument Approach Procedures (TERPS)	`FAA forms 8260-3, 8260-4, and 8260-5 incorporate standard instrument approach procedures for TERPS. It appears that the rules that are followed by the FAA for formulating approach procedures are not a part of the CFRs; the forms used by the FAA are given the status of CFR using a not so direct a method. These types of roundabout references should be avoided for the RLVs since the information scattered in the various forms is cumbersome and it is not at all obvious to the reader if the rules are consistent.
Editor's Note		parts 97.21 through 97.35 are the TERPS procedures; they are not published in the CFRs.	These rules have been used as a basis for the above-mentioned FAA forms but they are not a part of CFRs. Such roundabout specification of rules should be

			avoided for RLVs.

14 CFR 99 Security Control of Air Traffic

Effective Date	10/18/02
Contents and review purpose	This part prescribes rules for operation within Air Defense Identification Zones. These rules were reviewed for applicability to RLVs.

Subpart A - General			
Section	Title	Summary of Part	Notes/RLV Questions
99.1	Applicability	Specifies operating rules for civil aircraft in defense areas.	Applicable to RLVs. Currently the operations are approved for aircraft with airspeed less than 180 knots and listening to the appropriate frequency. For RLVs there may be other considerations such as use of RLVs as missiles.
99.3	Definitions	Definition of terms.	Definitions of RLV specific terms need to be included.
99.5	Emergency Situations	Violation of security rules is allowed in case of emergencies to the extent that the safety of flight needs to be maintained. However, pilot should report the deviation to the communication facility where the flight plans or position reports are normally filed as soon as possible.	Since RLVs travel at a higher speed, the violations may have to be reported by the RLV ground operators to the affected military installations as soon as the situation allows.
99.7	Special Security Instructions	There may be agreements between the FAA and DoD in addition to the rules noted in this part.	Applicable to the RLVs. This needs to be considered for interagency coordination between the FAA and DoD.

99.9	Radio Requirements	Requirements for communication between the pilot and the appropriate aeronautical facility. The aircraft flight plan cannot deviate by more than 5 minutes from the actual.	For RLVs this requirement may include previous approvals from the ADIZ. Tolerance between the actual and planned flight has to be more than 5 minutes.
99.11	ADIZ Flight Plan Requirements	Requirements for filing, activating and closing the flight plan with the appropriate aeronautical facility.	DO RLVs deal with aeronautical facilities or is there a need for a special facility? What should these flight plans contain above and beyond what was recognized in Part 91 requirements?
99.12	Transponder-on Requirements	Must operate with an operable radar beacon transponder including altitude encoding.	RLV requirements should include transponder requirements for normal operations. Note that the balloons and gliders without an engine-driven electrical system is currently exempted. If RLV systems are incrementally certified, first as a balloon or a glider before the installation of the engine, and subsequently with the engine, transponder requirements must be imposed.
99.15	Arrival or Completion Notice	Notice of arrival or completion is required unless not noted in the flight plan.	Applies to RLVs.

99.17	Position Reports, Aircraft Operating in or penetrating an ADIZ; IFR	Part 91.183 requirements hold for controlled space and part 99.19 holds for uncontrolled airspace.	Applicable to RLVs.
99.19	Position Reports, Aircraft Operating in or penetrating an ADIZ; DVFR	Rules for operation.	Applies to RLVs. Workload restrictions for an RLV pilot should be considered and there may be a need for automating this chore.
99.21	Position Reports, Aircraft Entering the United States Through an ADIZ; United States Aircraft	Rules for operation	Same as above
99.23	Position Reports, Aircraft Entering the United States Through an ADIZ; Foreign Aircraft	Rules for operation	Same as above. However security implications of a foreign RLV entering a defense identification zones should be reconsidered. This may be a bilateral issue to be explored in interagency cooperation.
99.27	Deviation From Flight Plans and ATC Clearances and Instructions	No deviations are allowed.	Applicable to RLVS also.

99.29	Radio Failure; DVFR	Proceed as planned, land as soon as possible and report the failure as soon as possible	FOR RLVs is there a security and a safety need to device an alternate communication device?
99.31	Radio Failure; IFR	Follow 91.185	FOR RLVs is there a security and a safety need to device an alternate communication device?
Subpart B - Designated Air Defense Identification Zones			
99.41	General	ADIZ zones are specified in the following parts.	Applicable to RLVs
99.42	Contiguous U.S. ADIZ		
99.43	Alaska ADIZ		
99.45	Guam ADIZ		
99.47	Hawaii ADIZ		

99.49	Defense Area	All airspace of the United States is designated as Defense Area except that is already an ADIZ.	Should the rules be more stringent for RLVs noting that an RLV can be used to breech security in a much significant manner than an airplane?

14 CFR 105 Parachute Operations

Effective Date	10/18/2002
Contents and review purpose	This FAR contains requirements for parachute operations conducted in the US. This FAR was reviewed for its applicability to RLVs, particularly those used for vehicle or stage recovery.

Section	Title	Summary of Part	Notes/RLV Questions
Subpart A - General			
105.1	Applicability	Covers all US parachute operations with the exception of those resulting from in-flight emergencies, servicing of a ground emergency (with approval), and military operations (under most circumstances – enumerated).	OK
105.3	Definitions	Provided definitions include approved parachute, automatic activation device, direct supervision, drop zone, foreign parachutist, freefall, main parachute, object, parachute drop, parachute jump, parachute operation, parachutist, parachutist in charge, passenger parachutist, pilot chute, ram-air parachute, reserve parachute, single-harness dual parachute system, tandem parachute operation, and tandem parachute system.	Need to look at in more detail, specifically examine TSO C-23 Drop zone is referenced to nearest VOR – is this still appropriate Some problems with the use of the word aircraft

Section	Title	Summary of Part	Notes/RLV Questions
105.5	General	Parachute operations are not allowed if such use would present a hazard to air traffic or property on the surface.	OK
105.7	Use of Alcohol and Drugs	No parachute operations by anyone who is or appears to be under the influence of alcohol or drugs	OK
105.9	Inspections	Administrator has authority to inspect all operations covered by this part.	OK
Subpart B – Operating Rules			
105.13	Radio Equipment and Use Requirements	Requires establishment and maintenance of radio communications between aircraft dropped objects of persons and appropriate ATC in the time immediately before commencing parachute operations until after the operations are complete. Loss of radio communications requires parachute operations to be aborted.	OK – minor language issue with term aircraft.
105.15	Information Required and Notice of Cancellation or Postponement of a Parachute Operation	Enumerates information to be provided to obtain authorization for parachute operations including location of drop zone, altitude drop will commence, identification of aircraft involved, and information on the requester. Also states that relevant qualifications/certifications of requester must be made available to FAA or other law enforcement if requested. Finally, the FAA must be notified of any	OK – except for similar issues with term aircraft.

Section	Title	Summary of Part	Notes/RLV Questions
		change or cancellation of intended parachute operations.	
105.17	Flight Visibility and Clearance from Cloud Requirements	States no parachute operations into or through clouds and provides table on minimum visibility and distance from clouds	Imposes a large limitation on downstream range or reentry area – needs to be examined in detail.
105.19	Parachute Operations Between Sunset and Sunrise	No night drops unless person or object descending from aircraft displays a light that is visible for at least three statute miles and that light stays illuminated from the time of parachute deployment to reaching the surface	Imposes a large limitation on range and reentry. Need to examine in detail.
105.21	Parachute Operations Over or Into a Congested Area or an Open-Air Assembly of Persons	States such operations are not allowed without proper authorization obtained via the requirements of part 105.15. May drift over congested or open-air assembly areas provided sufficient altitude exists to not cause a hazard to those on the ground.	Imposes a large limitation on downstream range or reentry area – needs to be examined in detail.
105.23	Parachute Operations Over or Into Airports	States such operations are not allowed unless prior approval of ATC and airport management has been obtained AND two-way communications are maintained with the airport tower. Parachutists may drift over airports provided they stay at least 2000 feet above traffic pattern.	OK

Section	Title	Summary of Part	Notes/RLV Questions
105.25	Parachute Operations in Designated Airspace	States limitations on where parachute operations can take place with and without appropriate approvals. Also states the time periods when notifications of proposed parachute operations need to be made to the FAA. Finally, exempts the military from the majority of these notification requirements.	OK
Subpart C – Parachute Equipment and Packing			
105.41	Applicability	Covers all parachute equipment used in civil parachute operations.	OK
105.43	Use of Single-Harness, Dual Parachute Systems	Operations are not allowed unless specific requirements on packing and days since packing are adhered to. This includes 120 days for non-natural fibers (e.g. nylon) and 60 days for all natural fibers (e.g. silk). Also states that automatic activation systems must be maintained to the OEM's specifications.	OK
105.45	Use of Tandem Parachute Systems	Operations are not allowed unless specific competency requirements are met by the parachutist in charge and certain stipulations on the packing of the chutes are also complied with. Also contains requirements for the main parachute to be equipped with a single release system and the reserve chute to comply with TSO C-23.	Need to review TSO C-23; also need to look at the types of chutes used for vehicle or stage recovery to determine applicability.

Section	Title	Summary of Part	Notes/RLV Questions
105.47	Use of Static Lines	Not allowed without the use of an assist device. Prescribes certain requirements for the assist device including overall length, static load strength, and specific attach points. Note: assist devices are not required for direct deployed ram-air parachutes.	Need to determine if there is any applicability here. Doubtful given the trajectories and velocities involved.
105.49	Foreign Parachutists and Equipment	Not allowed unless this part is complied with OR the rules of the foreign parachutist civil aviation authority.	OK

14 CFR 119 Certification: Air Carriers and Commercial Operators

Effective Date	10/18/2002
Contents and review purpose	This FAR contains operating requirements for air carriers and commercial operators, as well as operators not providing common carriage but who intend to operate aircraft with a seat configuration of more than 20 passengers or with a maximum payload capacity that exceeds 6000 pounds. It was reviewed to determine applicability and need for similar types of requirements for large RLVs.

Section	Title	Summary of Part	Notes/RLV Questions
Subpart A – General			
119.1	Applicability	Prescribes operator certificates, operator requirements, requirements for management personnel for operations, flights for different purposes. All of these requirements are for a seat configuration of 20 or more passengers or a maximum payload of 6,000 pounds or more.	RLV requirements may be tiered with appropriate weight and seating requirements or other discriminators. This provides a means to categorize risks and complexity of equipage needed to support the passenger and payload.
119.3	Definitions	Provided definitions include all cargo operations, certificate holding district office, commuter operation, direct air carrier, domestic operation, empty weight, flag operation, justifiable aircraft equipment, kind of operation, maximum payload capacity, maximum zero fuel weight, noncommon carriage, on-demand operation, passenger-carrying operation, principal base of operations, provisional airport, regular airport, scheduled operation, supplemental operation, wet	Depending upon the criteria used for categorizing RLVs, new definitions may be required.

Section	Title	Summary of Part	Notes/RLV Questions
		lease, and the phrase, “when common carriage is not involved or operations not involving common carriage”.	
119.5	Certifications, Authorizations, and Prohibitions	This is authorization for operating as an air carrier or to conduct operations in specific geographical areas.	Applicable to RLVs.
119.7	Operations Specifications	Operations specifications must contain both authorizations, and limitations.	Applicable to RLVs.
119.9	Use of Business Names	The same name as was authorized should be used for operations.	Applicable to RLVs.
Subpart B – Applicability of Operating Requirements to Different Kinds of Operations Under Parts 121, 125, and 135 of this Chapter			
119.21	Commercial Operators Engaged in Intrastate Common Carriage and Direct Air Carriers	Interstate requirements.	Need not only interstate within the U.S. but also international agreements.
119.23	Operators Engaged in Passenger-Carrying Operations,	Rules when common carriage is not involved are no different unless waivers are authorized.	Applicable to RLVs.

Section	Title	Summary of Part	Notes/RLV Questions
	Cargo Operations, or Both with Airplanes When Common Carriage is not Involved		
119.25	Rotorcraft Operations: Direct Air Carriers and Commercial Operators	Certification of operations should be in accordance with the actual operations.	Applicable to RLVs.
Subpart C – Certification, Operations Specifications, and Certain Other Requirements for Operations Conducted Under Part 121 or Part 135 of This Chapter			
119.31	Applicability	Requirements for operations under part 121 or part 135.	Rules for RLVs should be similar to these but with the criteria applied to categorize RLVs.
119.33	General Requirements	U.S. citizenship, operating certificate which covers operating specification to prescribe authorizations, limitations, and procedures.	Applicable to RLVs.
119.35	Certificate Application Requirements for All Operators	Details of the application	Applicable to RLVs.
119.36	Additional Certificate Application Requirements	Additional information in the application.	Applicable to RLVs.

Section	Title	Summary of Part	Notes/RLV Questions
	for Commercial Operators		
119.37	Contents of an Air Carrier Certificate or Operating Certificate	Contents of the certificates	Applicable to RLVs.
119.39	Issuing or Denying a Certificate	Conditions under which a certificate is issued.	Applicable to RLVs.
119.41	Amending a Certificate	Amendments that are required for the safety in air commerce and public interest. Petition process is also described.	Applicable to RLVs.
119.43	Certificate Holder’s Duty to Maintain Operations Specifications	These requirements prescribe operator's responsibility to maintain compliance to conditions under which the certificates were issued.	Applicable to RLVs.
119.45	[Reserved]	N/A	N/A
119.47	Maintaining a Principle base of Operations, Main Operations	Other requirements	Applicable to RLVs.

Section	Title	Summary of Part	Notes/RLV Questions
	Base, and Main Maintenance Base; Change of Address		
119.49	Contents of the Operations Specifications	Operations specifications specify what the operator is authorized to do and what the operator is not authorized to do. There is a list of considerations but the administrator can add to the list.	Applicable to RLVs.
119.51	Amending Operations Specifications	Details of how the operations specifications can be amended by the administrator, as well as the petition process.	Applicable to RLVs.
119.53	Wet Leasing of Aircraft and Other Arrangements for Transportation by Air	Certification of all facets of operation as well as personnel is required to be adequate for operation at hand.	Applicable to RLVs.
119.55	Obtaining Deviation Authority to Perform Operations Under a US Military Contract	Deviation may be granted under certain conditions to protect life or property.	Applicable to RLVs.
119.57	Obtaining Deviation Authority to Perform an	In an emergency, oral authorization by the administrator is adequate.	Applicable to RLVs.

Section	Title	Summary of Part	Notes/RLV Questions
	Emergency Operation		
11.59	Conducting Tests and Inspections	Tests and inspections to determine certificate holder's compliance.	Applicable to RLVs.
119.61	Duration and Surrender of Certificate and Operations Specifications	Conditions for revoking a certificate.	Applicable to RLVs.
119.63	Recency of Operation	Currency in operational knowledge is imposed even if the operator has the certificate for the type of operation.	Applicable to RLVs- there is a need to determine what the measure of currency is since that used in aviation namely days may not be adequate.
119.65	Management Personnel Required for Operations Conducted Under Part 121 of this Chapter	To ensure safety in its operations.	Applicable to RLVs. However, this item imposes an organizational structure. For RLVs, it may be better to specify a person's responsibility rather than his title.
119.67	Management Personnel: Qualifications for Operations Conducted Under Part 121	Qualifications for management personnel	Applicable to RLVs.

Section	Title	Summary of Part	Notes/RLV Questions
	of this Chapter		
119.69	Management Personnel Required for Operations Conducted Under Part 135 of this Chapter	To ensure safety in its operations.	Applicable to RLVs. However, this item imposes an organizational structure. For RLVs, it may be better to specify a person's responsibility rather than his title.
119.71	Management Personnel: Qualifications for Operations Conducted Under Part 135 of this Chapter	Qualifications for management personnel	Applicable to RLVs.

14 CFR 121 Operating Requirement: Domestic, Flag, and Supplemental Operations

Effective Date	11/4/02
Contents and review purpose	14 CFR 121 specifies the rules that an air carrier must follow once granted an operating certificate under this part. This text was reviewed to assess applicability and sufficiency of these requirements for RLVs.

Section	Title	Summary of Part	Notes/RLV Questions
Special Federal Aviation Regulation No. 14	Same	Specifies the Administrator may grant performance allowances (credit) for standby power on transport category airplanes. It further provides definitions and the specifications for these instances.	Not applicable to RLV.
Special Federal Aviation Regulation No. 36	Same	Refers to major repair and return to service issues. Linked to an amendment published at 66FR41116 Aug 6, 2001	May have applicability to RLV with modifications.
Special Federal Aviation Regulation No. 50-2 [Note]	Same	Text in Part 91.	
Special Federal Aviation Regulation No. 58	Same	Discusses training, evaluation, and certification for crewmembers, dispatchers and other operations.	May have applicability to RLV with modifications.
Special Federal Aviation Regulation No. 78 [Note]	Same	Text in Part 91.	
Special Federal	Same	Provides guidance on alternative	Not Applicable to RLV.

Section	Title	Summary of Part	Notes/RLV Questions
Aviation Regulation No. 80		communications and dispatching procedures.	
Special Federal Aviation Regulation No. 89	Same	Specifies flight data recorder models and requirements that can be suspended .	Not applicable to RLV.
Special Federal Aviation Regulation No. 92-4	Same	Design	Not applicable to RLV.
Special Federal Aviation Regulation No. 93 [Note]	Same	Text in Part 61.	
Subpart A -- General.			
121.1	Applicability.	Domestic, flag, & supplemental ops of each person who holds or required to hold an Air Carrier Cert or Op Cert under Part 119; employees performing maintenance, preventative maintenance & alteration of an aircraft; non-stop site seeing with 30 and fewer seats and max load of 7,500 lbs	Not applicable to RLV.
121.2	Compliance schedule for operators that transition to part 121; certain new entrant operators.	There are provisions for those under Part 135 to comply on a regular basis as well as an accelerated basis. Turboprop airplanes with 10-19 seats have additional compliance standards.	Not applicable to RLV.

Section	Title	Summary of Part	Notes/RLV Questions
121.4	Applicability of rules to unauthorized operators.	Rules referring to persons certificated under Part 119 also apply to any person engaged in ops governed by this part without the appropriate cert.	Not applicable to RLV.
121.11	Rules applicable to operations in a foreign country.	Cert holders comply with foreign air traffic rules of country flying in except where rules of this Part are more restrictive and don't violate rules of the foreign country.	Not applicable to RLV.
121.15	Carriage of narcotic drugs, marihuana, and depressant or stimulant drugs or substances.	If a cert holder permits an owned or leased aircraft to be engaged ion an operation in violation of 91.9(a) then that is a grounds for suspension or revocation of cert.	Applicable in General to RLVs.
Subpart B -- Certification Rules for Domestic and Flag Air Carriers [Reserved]			
Subpart C -- Certification Rules for Supplemental Air Carriers and Commercial Operators [Reserved]			
Subpart D -- Rules Governing All Certificate Holders Under This Part [Reserved]			
Subpart E -- Approval of Routes: Domestic and Flag Operations			
121.91	Applicability.	Prescribes rules for obtaining approval routes by cert holders conducting domestic or flag ops.	May be applicable to RLVs with some modifications and appropriate context for RLVs.
121.93	Route requirements: General.	Route scheduling: Cert holder must show they can satisfactorily operate between each regular, provisional, and refueling airport on route; must have facilities and service per 121.97 through 121.107	May be applicable to RLVs with some modifications and appropriate context for RLVs.
121.95	Route width.	Approved routes and segments over US federal airways or foreign airways have a width equal of those airways or routes	May be applicable to RLVs with some modifications and appropriate context for RLVs. This requires the phased

Section	Title	Summary of Part	Notes/RLV Questions
			approach to integration into the NAS.
121.97	Airports: Required data.	Each cert holder must show they have adequate and properly equipped airports for the operation Lists aeronautical data required for each airport	May be applicable to RLVs with some modifications and appropriate context for RLVs.
121.99	Communication facilities.	Cert holder must have 2-way comm that will ensure reliable and rapid comm under normal operating conditions	May be applicable to RLVs with some modifications and appropriate context for RLVs.
121.101	Weather reporting facilities.	Cert holder must show there are enough wx reporting services along route to ensure wx reports necessary for ops. In CONUS can only use US National Wx Service, outside only use wx service approved by FAA Administrator	May be applicable to RLVs with some modifications and appropriate context for RLVs. This is performed at the launch site and landing site.
121.103	En route navigational facilities.	Cert holder must show non-visual ground aids are available over route; located to allow regular, provisional, refueling or alternate airport nav Non-visual ground aids are not required for Day VFR that can be conducted by Pilotage; night VFR if reliable lighted landmarks are adequate; or where celestial or other nav aids approved	Not applicable to RLVs.
121.105	Servicing and maintenance facilities.	Cert holder must show adequate and competent personnel, facilities and equip are avail along route for proper servicing, maintenance, and prevent maint	Not Applicable to RLVs.
121.107	Dispatch	Cert holder must show enough dispatch	Not applicable to RLVs.

Section	Title	Summary of Part	Notes/RLV Questions
	centers.	centers to ensure proper control of each flight.	
Subpart F -- Approval of Areas and Routes for Supplemental Operations			
121.111	Applicability.	For approval of supplemental ops	Not applicable to RLVs CONOPS.
121.113	Area and route requirements: General.	Must show: able to op IAW applicable reqs for each area outside US for request; able to conduct ops over and nav facilities associated with, Federal airways, foreign airways, ADRs; and all IFR and night VFR ops over Fed airways, foreign airways, controlled airspace or ADR.	Not applicable to RLVs CONOPS
121.115	Route width.	Routes or segments over Fed airways, foreign airways, or advisory routes have a width equal to those of designated airway.	Not applicable to RLVs CONOPS
121.117	Airports: Required data.	Each cert holder must show they have adequate and properly equipped airports for the operation Lists aeronautical data required for each airport	May be applicable to RLVs with some modifications and appropriate context for RLVs.
121.119	Weather reporting facilities.	Cert holder must show there are enough wx reporting services along route to ensure wx reports necessary for ops. In CONUS can only use US National Wx Service, outside only use wx service approved by FAA Administrator	May be applicable to RLVs with some modifications and appropriate context for RLVs. Not necessarily only use National wx service since each launch site now provides this information.
121.121	En route navigational facilities.	Cert holder must show non-visual ground aids are available over route w/ degree of accuracy requirements for	Not applicable to RLV.

Section	Title	Summary of Part	Notes/RLV Questions
		ATC Non-visual ground aids are not required for Day VFR that can be conducted by Pilotage; night VFR if reliable lighted landmarks are adequate; or where celestial or other navigational aids approved; non-visual ground navigational aids that are requirements for approved routes outside of controlled airspace specified in the cert holder's ops specs.	
121.123	Servicing maintenance facilities.	Cert holder must show adequate and competent personnel, facilities and equip are avail along route for proper servicing, maintenance, and preventative maintenance	May be applicable to RLVs with some modifications and appropriate context for RLVs.
121.125	Flight following system.	Cert holder must show it has: an approved flight following system established IAW subpart U and adequate for the proper monitoring of each flight; flight following centers	
121.127	Flight following system; requirements.	Must have adequate personnel and facilities to provide the info necessary to initiate and safe conduct of each flight to: flight crew, persons designated be cert holder to perform ops control of AC; system has means of communication by private or pub means to monitor flight; cert holder performing supplemental ops show that personnel in 121.127(a) are able to perform required duties.	May be applicable to RLVs with some modifications and appropriate context for RLVs.
Subpart G -- Manual Requirements			

Section	Title	Summary of Part	Notes/RLV Questions
121.131	Applicability.	Prescribes requirements for preparing and maintaining manuals.	Applicable to RLVs with some modifications.
121.133	Preparation.	Cert holder shall prepare and keep current for use and guidance of flight, ground ops, and management personnel. May prepare that part of manual containing maintenance info and instructions in printed form or other acceptable by FAA.	Applicable to RLVs with some modifications.
121.135	Contents.	Lists the required contents of the manuals.	Applicable to RLVs with some modifications.
121.137	Distribution and availability.	Cert holders shall distribute manuals to ground ops and maintenance personnel, crewmembers, and reps of the FAA assigned to it.	Applicable to RLVs with some modifications.
121.139	Requirements for manual aboard aircraft: Supplemental operations.	Each Cert holder shall carry parts of manual on-board conducting supplemental ops, if not printed a suitable reading device must be brought on-board as well.	Applicable to RLVs with some modifications.
121.141	Airplane flight manual.	Lists the requirements for manuals content.	Applicable to RLVs with some modifications.
Subpart H -- Aircraft Requirements .			
121.151	Applicability.	All Cert holders.	Not applicable to RLVs.
121.153	Aircraft requirements: General.	Cert holder can only operate an aircraft if the conditions in 121.153 are met.	Not applicable to RLVs.
121.155	[Reserved]		Not applicable to RLVs.
121.157	Aircraft certification and equipment requirements.	Lists the requirements for certification and equipment whether passenger or cargo.	Not applicable to RLVs.

Section	Title	Summary of Part	Notes/RLV Questions
121.159	Single-engine airplanes prohibited.	No single engine aircraft may be operated under this part.	Not applicable to RLVs.
121.161	Airplane limitations: Type of route.	No Cert holder may fly a 2 or 3 engine aircraft over a route that contains a point farther then 1 hour flying time. No extended overwater operation except for certain aircraft.	Not applicable to RLVs.
121.163	Aircraft proving tests.	4 definitions provided: Initial airplane proving tests, Proving tests for kinds of operations, Proving tests for materially altered airplanes, and Definition of materially altered.	Not applicable to RLVs.
Subpart I -- Airplane Performance Operating Limitations .			
121.171	Applicability.	All Cert holders. Defines effective length of runway and obstruction clearance plane.	Not applicable to RLVs.
121.173	General.	Compliance to 121.175 thru 121.187 for Cert holder operating reciprocating engine powered airplane; Compliance with 121.189 thru 121.197 for operating turbine engine powered aircraft; Large Transport compliance with 121.199 thru 121.205	Not applicable to RLVs.
121.175	Airplanes: Reciprocating engine-powered: Weight limitations.	Specifies maximum take-off and landing weights for reciprocating engine aircraft at airports of elevations outside range of capabilities.	Not applicable to RLVs.
121.177	Airplanes: Reciprocating	Specifies takeoff limits to safely stop, climb, and height clearances	Not applicable to RLVs.

Section	Title	Summary of Part	Notes/RLV Questions
	engine-powered: Takeoff limitations.		
121.179	Airplanes: Reciprocating engine-powered: En route limitations: All engines operating.	Specifies an all engine, normal consumption rate for climb rates for reciprocating engine powered aircraft.	Not applicable to RLVs.
121.181	Airplanes: Reciprocating engine-powered: En route limitations: One engine inoperative.	Specifies a one engine out, normal consumption rate for climb rates for reciprocating engine powered aircraft. With approval a Cert holder may operate an aircraft at an all-engine-operating altitude with an engine out to an alternate airport. If approved must follow paragraph (c).	Not applicable to RLVs.
121.183	Part 25 airplanes with four or more engines: Reciprocating engine powered: En route limitations: Two engines inoperative.	Can only operate 4 or more engines under conditions of being within 90 minutes of an airport and specific climb rate with 2 engines out.	Not applicable to RLVs.
121.185	Airplanes:	Provides take off guidance for fuel and	Not applicable to RLVs.

Section	Title	Summary of Part	Notes/RLV Questions
	Reciprocating engine-powered: Landing limitations: Destination airport.	oil . It specifies the full stop requirements, suitable runways, and considerations for wind speed and direction.	
121.187	Airplanes: Reciprocating engine-powered: Landing limitations: Alternate airport.	Limits listing of an alternate airport to those aircraft that can be fully stopped within 70% of the effective runway length. Excludes large non-transports.	Not applicable to RLVs.
121.189	Airplanes: Turbine engine powered: Takeoff limitations.	Specifies take-off criteria for Turbine engined aircraft. Uses the Flight Manual as a reference for weights, climb, distances, etc.	Not applicable to RLVs.
121.191	Airplanes: Turbine engine powered: En route limitations: One engine inoperative.	Specifies the en route flight limitations of slope and , altitude and obstructions for one engine out on turbine engine aircraft. Additionally, lists assumptions for the conditions of the engine out such as fuel jettisoning, fuel and oil consumption as well as alternate airport.	Not applicable to RLVs.
121.193	Airplanes: Turbine engine powered: En route	Specifies the en route flight limitations of slope and altitude and obstructions for two engine out on a turbine engine aircraft. Additionally, lists assumptions	Not applicable to RLVs.

Section	Title	Summary of Part	Notes/RLV Questions
	limitations: Two engines inoperative.	for the conditions of the engine out such as fuel jettisoning, fuel and oil consumption as well as alternate airport. Specifies a general requirement and 2 areas of requirements one for 2 different certifications times.	
121.195	Airplanes: Turbine engine powered: Landing limitations: Destination airports.	Specifies the use of the Flight Manual's guides for weight, and elevation of a destination airport. Considers wind conditions as well.	Not applicable to RLVs.
121.197	Airplanes: Turbine engine powered: Landing limitations: Alternate airports.	Limits listing of an alternate airport to those aircraft that can be fully stopped within 70% of the effective runway length for turbo prop and 60% for turbojets.	Not applicable to RLVs.
121.198	Cargo service airplanes: Increased zero fuel and landing weights.	Specifies which aircraft models can be operated in cargo service only at increased zero fuel and landing weights. Provides allowances for the zero fuel weight and structural landing weight	Not applicable to RLVs.
121.199	Non-transport category airplanes: Takeoff limitations.	Defines effective length of runway. Specifies the non transport takeoff weight for safe takeoff and flight conditions.	Not applicable to RLVs.
121.201	Non-transport	Specifies that a Non-transport plane	Not applicable to RLVs.

Section	Title	Summary of Part	Notes/RLV Questions
	category airplanes: En route limitations: One engine inoperative.	with one engine out may not take-off if the climb rate is less than 50 ft per minute. Other factors apply that the Administrator may waive.	
121.203	Non-transport category airplanes: Landing limitations: Destination airport.	Specifies take off weight limits in order to ensure full stop within 60% of effective runway length.	Not applicable to RLVs.
121.205	Non-transport category airplanes: Landing limitations: Alternate airport.	Specifies same as 121.203 but within 70% for alternate airport.	Not applicable to RLVs.
121.207	Provisionally certificated airplanes: Operating limitations.	Must maintain log of each flight, inspections, and all maintenance.	Applicable to RLVs.
Subpart J -- Special Airworthiness Requirements			
121.211	Applicability.	General applicability of the prescribed Special Airworthiness requirements	Design, not applicable to O&M.
121.213	[Reserved]		Design, not applicable to O&M.
121.215	Cabin interiors.	Design of materials for fire retardant.	Design, not applicable to O&M.
121.217	Internal doors.	Design	Design, not applicable to O&M.
121.219	Ventilation.	Design, but maintenance must also	Design, not applicable to O&M.

Section	Title	Summary of Part	Notes/RLV Questions
		ensure the carbon monoxide is limited to on part to 20,000 parts of air.	
121.221	Fire precautions.	Design and maintenance to ensure ventilation is properly maintained.	Design, not applicable to O&M.
121.223	Proof of compliance with §121.221.	Design and test of systems.	Design, not applicable to O&M.
121.225	Propeller deicing fluid.	Design	Design, not applicable to O&M.
121.227	Pressure cross-feed arrangements.	Design, no cross feeds for fuel can occur that pass through parts carrying passengers.	Design, not applicable to O&M.
121.229	Location of fuel tanks.	Design	Design, not applicable to O&M.
121.231	Fuel system lines and fittings.	Design	Design, not applicable to O&M.
121.233	Fuel lines and fittings in designated fire zones.	Design	Design, not applicable to O&M.
121.235	Fuel valves.	Design	Design, not applicable to O&M.
121.237	Oil lines and fittings in designated fire zones.	Design	Design, not applicable to O&M.
121.239	Oil valves.	Design	Design, not applicable to O&M.
121.241	Oil system drains.	Design	Design, not applicable to O&M.
121.243	Engine breather lines.	Design	Design, not applicable to O&M.
121.245	Fire walls.	Design	Design, not applicable to O&M.

Section	Title	Summary of Part	Notes/RLV Questions
121.247	Fire-wall construction.	Design	Design, not applicable to O&M.
121.249	Cowling.	Design	Design, not applicable to O&M.
121.251	Engine accessory section diaphragm.	Design	Design, not applicable to O&M.
121.253	Powerplant fire protection.	Design	Design, not applicable to O&M.
121.255	Flammable fluids.	Design	Design, not applicable to O&M.
121.257	Shutoff means.	Design	Design, not applicable to O&M.
121.259	Lines and fittings.	Design	Design, not applicable to O&M.
121.261	Vent and drain lines.	Design	Design, not applicable to O&M. Design, not applicable to O&M.
121.263	Fire-extinguishing systems.	Design	
121.265	Fire-extinguishing agents.	Design, maintenance for replenishment of released agents.	Design, not applicable to O&M.
121.267	Extinguishing agent container pressure relief.	Design, maintenance for replenishment of released agents.	Design, not applicable to O&M.
121.269	Extinguishing agent container compartment temperature.	Design	Design, not applicable to O&M.
121.271	Fire-extinguishing system	Design	Design, not applicable to O&M.

Section	Title	Summary of Part	Notes/RLV Questions
	materials.		
121.273	Fire-detector systems.	Design	Design, not applicable to O&M.
121.275	Fire detectors.	Design	Design, not applicable to O&M.
121.277	Protection of other airplane components against fire.	Design	Design, not applicable to O&M.
121.279	Control of engine rotation.	Design	Design, not applicable to O&M.
121.281	Fuel system independence.	Design	Design, not applicable to O&M.
121.283	Induction system ice prevention.	Design	Design, not applicable to O&M.
121.285	Carriage of cargo in passenger compartments.	Design	Design, not applicable to O&M.
121.287	Carriage of cargo in cargo compartments.	Design	Design, not applicable to O&M.
121.289	Landing gear: Aural warning device.	Design	Design, not applicable to O&M.
121.291	Demonstration of emergency evacuation procedures.	Operations demonstration of the fire extinguishing system.	Applicable to RLVs in proper context of crew recovery system and passenger escape systems.
121.293	Special airworthiness requirements	Design	Design, not applicable to O&M.

Section	Title	Summary of Part	Notes/RLV Questions
	for nontransport category airplanes type certificated after December 31, 1964.		
Subpart K -- Instrument and Equipment Requirements			
121.301	Applicability.	All certificate holders.	Design, not applicable to O&M.
121.303	Airplane instruments and equipment.	Design	Design, not applicable to O&M.
121.305	Flight and navigational equipment.	Design	Design, not applicable to O&M.
121.306	Portable electronic devices.	Operations limitations on electronic devices to prevent interference.	Applicable to RLVs in proper context.
121.307	Engine instruments.	Specifies engine indicators for safety of flight.	Applicable to RLVs in proper context.
121.308	Lavatory fire protection.	Must have smoke detectors in lavatory.	May have future applicability, but not envisioned in near term.
121.309	Emergency equipment.	Specifies emergency equipment that must be used in operating an airplane, such as fire extinguishers, first aid…	May have future applicability.
121.310	Additional emergency equipment.	Specifies additional emergency equipment that must be used in operating an airplane, such as emergency evacuation, lighting…	May have future applicability.
121.311	Seats, safety belts, and shoulder	Passenger safety issues.	May have future applicability

Section	Title	Summary of Part	Notes/RLV Questions
	harnesses.		
121.312	Materials for compartment interiors.	Design	Design, not applicable to O&M.
121.313	Miscellaneous equipment.	Specifies internal operations requirements such as fuses, power indicators…	
121.314	Cargo and baggage compartments.	Design	Design, not applicable to O&M.
121.315	Cockpit check procedure.	Specifies that each aircraft have cockpit checklists	
121.316	Fuel tanks.	Design	Design, not applicable to O&M.
121.317	Passenger information requirements, smoking prohibitions, and additional seat belt requirements.	Internal passenger safety and conduct	
121.318	Public address system.	Design	Design, not applicable to O&M.
121.319	Crewmember interphone system.	Design	Design, not applicable to O&M.
121.321	[Reserved]		
121.323	Instruments and equipment for operations at night.	Design	Design, not applicable to O&M.
121.325	Instruments	Specifies under IFR or over-the-top	Not applicable to RLVs.

Section	Title	Summary of Part	Notes/RLV Questions
	and equipment for operations under IFR or over-the-top.	flight, the aircraft must be equipped with an airspeed indicating system, sensitive altimeter, and instrument lights	
121.327	Supplemental oxygen: Reciprocating engine powered airplanes.	Design	Design, not applicable to O&M.
121.329	Supplemental oxygen for sustenance: Turbine engine powered airplanes.	Design	Design, not applicable to O&M.
121.331	Supplemental oxygen requirements for pressurized cabin airplanes: Reciprocating engine powered airplanes.	Design	Design, not applicable to O&M.
121.333	Supplemental oxygen for emergency descent and for first aid; turbine engine	Design	Design, not applicable to O&M.

Section	Title	Summary of Part	Notes/RLV Questions
	powered airplanes with pressured cabins.		
121.335	Equipment standards.	Specifies oxygen flow in oxygen apparatus for reciprocating and turbine engine aircraft.	Design, not applicable to O&M.
121.337	Protective breathing equipment.	Design	Design, not applicable to O&M.
121.339	Emergency equipment for extended over-water operations.	Specifies safety equipment for passengers and crew on-board.	May be applicable to RLVs.
121.340	Emergency flotation means.	To operate over water, there must be flotation devices on-board.	May have applicability to RLVs
121.341	Equipment for operations in icing conditions.	Specifies that if flying in icing conditions must have illumination to see the formation, and anti-icing	May be applicable in RLV context.
121.342	Pitot heat indication systems.	If a pitot heating system is used, then a pitot heating system indicator is required.	Design, not applicable to O&M.
121.343	Flight recorders.	Design, specifies the data to be recorded.	Useful for RLVs recorders or telemetry stream
121.344	Digital flight data recorders for transport category airplanes.	Specifies the data required for digital flight data recorders for turbine engine transport aircraft. Also provides allowances and schedule for install for various operations.	May be applicable to RLVs with some modifications and appropriate context for RLVs.

Section	Title	Summary of Part	Notes/RLV Questions
121.344a	Digital flight data recorders for 10-19 seat airplanes.	Specifies the same as above for 10-19 seat aircraft.	May be applicable to RLVs with some modifications and appropriate context for RLVs.
121.345	Radio equipment.	Specifies that all aircraft must be equipped with 2 separate and complete radio systems with independent antennas.	May be applicable to RLVs with some modifications and appropriate context for RLVs.
121.347	Radio equipment for operations under VFR over routes navigated by pilotage.	Specifies necessity for radio equipment for VFR flight under Pilotage. Must be able to communicate with at least one appropriate ground station and traffic control facility.	May be applicable to RLVs with some modifications and appropriate context for RLVs.
121.349	Radio equipment for operations under VFR over routes not navigated by pilotage or for operations under IFR or over-the-top.	Same specs as above and able to receive satisfactorily by either two independent systems radio navigation signals from all primary en route and approach navigational facilities intended to be used.	May be applicable to RLVs with some modifications and appropriate context for RLVs.
121.351	Radio equipment for extended overwater operations and for certain other	Must comply with 121.347 and 121.349 and have two long range navigation systems when VOR or ADF radio navigation equipment is unusable along a portion of the route.	May be applicable to RLVs with some modifications and appropriate context for RLVs.

Section	Title	Summary of Part	Notes/RLV Questions
	operations.		
121.353	Emergency equipment for operations over uninhabited terrain areas: Flag, supplemental, and certain domestic operators.	Specifies that no person may conduct flag or supplemental ops or a domestic op over uninhabited areas unless an aircraft has pyrotechnic signaling device, approved survival emergency locator transmitter, and enough survival kits for each occupant.	Not applicable to RLVs.
121.354	Terrain awareness and warning system.	Turbine powered aircraft must only be operated if there is an approved terrain awareness and warning system that meets the requirements in Technical Standard Order (TSO)-C151 and an approved terrain situational awareness display. Additionally, the aircraft Flight Manual shall have procedures for the systems.	Not applicable to RLVs.
121.355	Equipment for operations on which specialized means of navigation are used.	Provides guidance on use of the Doppler Radar and Inertial Navigation System.	Not applicable to RLVs.
121.356	Traffic Alert and Collision Avoidance System.	Specifies aircraft passenger numbers and the required traffic alert and collision avoidance system to be used. Greater than 30 requires Traffic Collision Avoidance System (TCAS) II,	Not applicable to RLVs.

Section	Title	Summary of Part	Notes/RLV Questions
		and 10-30 requires an approved traffic alert and collision avoidance system.	
121.357	Airborne weather radar equipment requirements.	Specifies any transport category airplane or a non-transport aircraft must have an approved airborne weather radar equipment. Further specifies how it should be operated.	Not applicable to RLVs.
121.358	Low-altitude windshear system equipment requirements.	Aircraft must have an airborne windshear warning and flight guidance system.	Not applicable to RLVs.
121.359	Cockpit voice recorders.	Specifies aircraft with 4 turbine engines or a large pressurized aircraft must have an approved cockpit recorder.	Not applicable to RLVs.
121.360	Ground proximity warning-glide slope deviation alerting system.	All turbine powered airplanes must operate with a ground proximity warning system that meets performance and environmental standards of TSO-C92.	Not applicable to RLVs.
Subpart L -- Maintenance, Preventive Maintenance, and Alterations			
121.361	Applicability.	Applies to all certificate holders.	May be applicable to RLVs with some modifications and appropriate context for RLVs.
121.363	Responsibility for airworthiness.	Each Cert holder is responsible for aircraft, performance of maintenance, preventive maintenance, or alterations.	May be applicable to RLVs with some modifications and appropriate context for RLVs.
121.365	Maintenance, preventive maintenance, and alteration	Must have an organization capable of doing the maintenance.	May be applicable to RLVs with some modifications and appropriate context for RLVs.

Section	Title	Summary of Part	Notes/RLV Questions
	organization.		
121.367	Maintenance, preventive maintenance, and alterations programs.	Each cert holder shall have an inspection program and program covering other maintenance, prevent maintenance, and alterations. The personnel shall be competent.	May be applicable to RLVs with some modifications and appropriate context for RLVs.
121.369	Manual requirements.	Cert holder must put in its manual a chart or description of the cert holder's organization required by 121.365. Also must contain the programs required by 121.367. And the manual must have a suitable system that preserves and retrieves information.	May be applicable to RLVs with some modifications and appropriate context for RLVs.
121.370	Repair assessment for Pressurized fuselages	Specifies requirements for particular airframes.	Not applicable.
121.371	Required inspection personnel.	Inspectors must be certified, must be under supervision and under an inspection unit, may not inspect the work person performed.	May be applicable to RLVs with some modifications and appropriate context for RLVs.
121.373	Continuing analysis and surveillance.	Cert holders shall establish and maintain a system for continuing analysis and surveillance	May be applicable to RLVs with some modifications and appropriate context for RLVs.
121.375	Maintenance and preventive maintenance training program.	Each Cert holder performing maint or preventive maint shall have a training program.	May be applicable to RLVs with some modifications and appropriate context for RLVs.
121.377	Maintenance and preventive maintenance	Provides provision for non-over – working maint personnel	May be applicable to RLVs with some modifications and appropriate context for RLVs.

Section	Title	Summary of Part	Notes/RLV Questions
	personnel duty time limitations.		
121.378	Certificate requirements.	Specifies requirement for maint, preventive maint, alterations and inspections hold an airman certification.	May be applicable to RLVs with some modifications and appropriate context for RLVs.
121.379	Authority to perform and approve maintenance, preventive maintenance, and alterations.	A cert holder may perform or make arrangements to perform maint, preventive maint and alterations as provided in its airworthiness maint program.	May be applicable to RLVs with some modifications and appropriate context for RLVs.
121.380	Maintenance recording requirements.	Specifies records a cert holder must maintain and particular data to be recorded.	May be applicable to RLVs with some modifications and appropriate context for RLVs.
121.380a	Transfer of maintenance records.	If a US registered aircraft is sold, the records for the aircraft specified in 121.380(a)(2) and 121.380(a)(1) shall be transferred to the purchaser.	May be applicable to RLVs with some modifications and appropriate context for RLVs.
Subpart M -- Airman and Crewmember Requirements			
121.381	Applicability.	Prescribes requirements for an airman and crewmember.	May be applicable to RLVs with some modifications and appropriate context for RLVs.
121.383	Airman: Limitations on use of services.	Specifies requirements for service as an airman such as certification as an airman and appropriate medical certs, qualified for the operation.	May be applicable to RLVs with some modifications and appropriate context for RLVs.
121.385	Composition of flight crew.	Minimum flight crew is 2 certified positions of pilots. Cert operator must have the minimum flight crew specified in the airworthiness cert or the flight manual.	Not directly applicable, must have RLV specific Pilotage guides.

Section	Title	Summary of Part	Notes/RLV Questions
121.387	Flight engineer.	Specifies that a certified flight engineer shall be on-board an aircraft of 80,000 lbs of more.	Not applicable.
121.389	Flight navigator and specialized navigation equipment.	Specifies that no aircraft can be operated outside the 48 CONUS when the position cannot be reliably fixed for a period of more than 1 hour. Maybe required to have a flight navigator or specialized navigation equipment.	Not applicable.
121.391	Flight attendants.	Specifies number and type of flight attendants for specific aircraft payload classes.	Not applicable.
121.393	Crewmember requirements at stops where passengers remain on-board.	Self explanatory	Not applicable.
121.395	Aircraft dispatcher: Domestic and flag operations.	Specifies that cert holders shall have enough dispatchers at each dispatch center to ensure proper operational control.	Not applicable.
121.397	Emergency and emergency evacuation duties.	Cert holder must have adequate personnel to ensure all emergency and safety functions are able to be performed.	Not applicable.
Subpart N -- Training Program			
121.400	Applicability and terms used.	Applies to 2 groups: propeller driven and turbojet cert holders. Defines the various types of training.	Applicable with modifications for RLVs specifically.
121.401	Training program:	Specifies that each cert holder shall establish and maintain a training	Applicable with modifications.

Section	Title	Summary of Part	Notes/RLV Questions
	General.	program, provide adequate ground and flight training facilities, provide and keep current each airplane, enough instructors among other general requirements.	
121.402	Training program: Special rules.	Only a cert holder may provide training under this part. May contract training provided it meets the criteria laid out.	Applicable with modifications.
121.403	Training program: Curriculum.	Specifies a cert holder must prepare and maintain a written training program. Further specifies the content of the curriculum.	Applicable with modifications.
121.404	Compliance dates: Crew and dispatcher resource management training.	Flight crew and Flight attendants must complete Crew Resource Management (CRM) or Dispatcher Resource Management (DRM) training.	Not applicable.
121.405	Training program and revision: Initial and final approval.	Specifies what must be submitted to the FAA Administrator to get initial and final approval of the training program.	Applicable with modifications.
121.406	Credit for previous CRM/DRM training.	Credit may be given for CRM or DRM considering training aids, devices, methods, and procedures used.	
121.407	Training program: Approval of airplane simulators and	Specifies the conditions under which simulators and training devices may be permitted in a training course. A simulator or training device may be used by more than one cert holder	Applicable with modifications.

Section	Title	Summary of Part	Notes/RLV Questions
	other training devices.	under specified conditions.	
121.409	Training courses using airplane simulators and other training devices.	Specifies the conditions in which an airplane simulator of other training device may be included in the training program.	Applicable with modifications.
121.411	Qualifications: Check airmen (airplane) and check airmen (simulator).	Specifies the requirements for qualification for check airmen for an airplane or check airmen for simulators. Further specifies that a check airman must meet requirements listed.	Applicable with modifications.
121.412	Qualifications: Flight instructors (airplane) and flight instructors (simulator).	Specifies the requirements for qualification for flight instructors for an airplane or flight instructors for simulators. Further specifies that a flight instructor must meet requirements listed.	Applicable with modifications.
121.413	Initial and transition training and checking requirements: Check airmen (airplane), check airmen (simulator).	Specifies the requirements for check airmen(airplane and simulator) including the ground training reqs and initial and transitional flight training for pilot check airmen, flight engineer check airmen, and flight navigator check airmen.	Applicable with modifications.
121.414	Initial and transition training and	Specifies the requirements for flight instructors (airplane and simulator) including the ground training reqs and	Applicable with modifications.

Section	Title	Summary of Part	Notes/RLV Questions
	checking requirements: flight instructors (airplane), flight instructors (simulator).	initial and transitional flight training for flight instructors, flight engineer instructors, and flight navigator instructors.	
121.415	Crewmember and dispatcher training requirements.	Specifies the training program requirements for ground training to the assignment of crewmember and dispatcher.	Applicable with modifications.
121.417	Crewmember emergency training.	Specifies that each training program shall provide emergency training wrt to each airplane type, model and configuration. It further specifies the content of the emergency training.	Applicable with modifications.
121.418	Differences training: Crewmembers and dispatchers.	Specifies the requirement for difference training for crewmembers and dispatchers.	Applicable with modifications.
121.419	Pilots and flight engineers: Initial, transition, and upgrade ground training.	Specifies the areas that initial, transition, and upgrade training must contain for pilots and flight engineers.	Applicable with modifications.
121.420	Flight navigators: Initial and transition ground training.	Specifies the areas that initial and transition training must contain for flight navigators.	Applicable with modifications.

Section	Title	Summary of Part	Notes/RLV Questions
121.421	Flight attendants: Initial and transition ground training.	Specifies the areas that initial and transition training must contain for attendants.	N/A during first phase of RLVs.
121.422	Aircraft dispatchers: Initial and transition ground training.	Specifies the areas that initial and transition training must contain for aircraft dispatchers.	Not applicable.
121.424	Pilots: Initial, transition and upgrade flight training.	Specifies the areas that initial, transition, and upgrade training must contain for pilots must include flight training and practice in the maneuvers and procedures set forth in the cert holder's low-altitude windshear flight program. Further broken into two groups of aircraft.	May be applicable to RLVs with some modifications and appropriate context for RLVs.
121.425	Flight engineers: Initial and transition flight training.	Specifies the areas that initial and transition training must contain for flight engineers to include training and practice in procedures related to carrying out	May be applicable to RLVs with some modifications and appropriate context for RLVs.
121.426	Flight navigators: Initial and transition flight training.	Specifies the areas that initial and transition training must contain for flight navigators to ensure proper proficiency.	May be applicable to RLVs with some modifications and appropriate context for RLVs.
121.427	Recurrent training.	Specifies crewmember and dispatcher training reqs and that they must be adequately trained to perform their duties with specific hrs of instructions.	Not applicable to RLVs.

Section	Title	Summary of Part	Notes/RLV Questions
121.429	Prohibited drugs.	Each cert holder shall provide each employee performing duties in App I with training.	This Title is a misnomer, it has nothing to do with drugs or drug prohibition.
Subpart O -- Crewmember Qualifications			
121.431	Applicability.	Prescribes crewmember qualifications for commuter operations under Part 135 of this chapter with airplanes with two pilots. Specifies the requirements for training center personnel.	May be applicable to RLVs with some modifications and appropriate context for RLVs.
121.432	General.	Second in cmd of an operation that requires 3 or more pilots must be fully qualified to act as pilot in command.	May be applicable to RLVs with some modifications and appropriate context for RLVs.
121.433	Training required.	Specifies the types of training required: Initial, differences, recurrent.	May be applicable to RLVs with some modifications and appropriate context for RLVs.
121.433a	Training requirements: Handling and carriage of dangerous articles and magnetized materials.	In order to handle hazardous materials or carriage of a person must have completed training within last 12 months.	May be applicable to RLVs with some modifications and appropriate context for RLVs.
121.434	Operating experience, operating cycles, and consolidation of knowledge and skills.	Specifies persons serving as crewmembers must have operating experience, operating cycles, and line operating flight time on the particular aircraft and position. Further specifies how the experience and cycles must be acquired for each position: pilot, flight engineer,…	May be applicable to RLVs with some modifications and appropriate context for RLVs.
121.437	Pilot	Outlines the certificates required by a	May be applicable to RLVs with

Section	Title	Summary of Part	Notes/RLV Questions
	qualification: Certificates required.	pilot in command of an aircraft or as a second in command.	some modifications and appropriate context for RLVs.
121.438	Pilot operating limitations and pairing requirements.	Specifies what take-offs and landings a pilot in command must perform given a second in command's minimal flight time.	May be applicable to RLVs with some modifications and appropriate context for RLVs.
121.439	Pilot qualification: Recent experience.	No cert holder may use any person to serve as a required pilot flight crewmember unless that person in the last 90 days has made 3 takeoffs and landings in the type aircraft.	May be applicable to RLVs with some modifications and appropriate context for RLVs.
121.440	Line checks.	No one may operate as pilot in command unless within the last 12 months person has passed a line check.	May be applicable to RLVs with some modifications and appropriate context for RLVs.
121.441	Proficiency checks.	No cert holder may use any person nor may any person serve as a pilot flight crewmember unless that person has completed a proficiency check. Further specifies the requirements for a proficiency check.	May be applicable to RLVs with some modifications and appropriate context for RLVs.
121.443	Pilot in command qualification: Route and airports.	Specifies that the cert holder must have a system to disseminate information to a pilot for the subjects listed in paragraph (b)	May be applicable to RLVs with some modifications and appropriate context for RLVs.
121.445	Pilot in command airport qualification: Special areas and airports.	Specifies the requirements for pilots in command to have for special areas and airports.	May be applicable to RLVs with some modifications and appropriate context for RLVs.

Section	Title	Summary of Part	Notes/RLV Questions
121.447	[Reserved]		
121.453	Flight engineer qualifications.	Specifies the flight engineer qualifications to serve as such to have within the last 6 months at least 50 hours of flight time on a similar aircraft.	May be applicable to RLVs with some modifications and appropriate context for RLVs.
121.455	Use of prohibited drugs.	No cert holder may use any person in Appendix I that has a prohibited drug.	May be applicable to RLVs with some modifications and appropriate context for RLVs.
121.457	Testing for prohibited drugs.	A cert holder employing anyone listed in Appendix I must have them drug tested per that Appendix. This holds for contractors of the cert holder also.	May be applicable to RLVs with some modifications and appropriate context for RLVs.
121.458	Misuse of alcohol.	Specifies the acceptable alcohol concentration, on-duty use, pre-duty use, following an accident and refusal to submit to a required alcohol test.	May be applicable to RLVs with some modifications and appropriate context for RLVs.
121.459	Testing for alcohol.	Each cert holder must have an established alcohol misuse prevention program. No cert holder may use an employee list in Appendix J.	May be applicable to RLVs with some modifications and appropriate context for RLVs.
Subpart P -- Aircraft Dispatcher Qualifications and Duty Time Limitations: DOMESTIC AND FLAG OPERATIONS; FLIGHT ATTENDANT DUTY PERIOD LIMITATIONS AND REST REQUIREMENTS: DOMESTIC, FLAG, AND SUPPLEMENTAL OPERATIONS			
121.461	Applicability.	Specifies qualifications and duty time limits for aircraft dispatchers and rest reqs for flight attendants.	May be applicable to RLVs in future CONOPS.
121.463	Aircraft dispatcher qualifications.	Specifies a large list of qualifications for aircraft dispatchers. This includes training, operations experience, and knows the operating procedures.	May be applicable to RLVs in future CONOPS.
121.465	Aircraft	Specifies duty time limitations for the	May be applicable to RLVs in

Section	Title	Summary of Part	Notes/RLV Questions
	dispatcher duty time limitations: Domestic and flag operations.	aircraft dispatcher for domestic or flag operations.	future CONOPS.
121.467	Flight attendant duty period limitations and rest requirements: Domestic, flag, and supplemental operations.	Defines Calendar day, Duty period, Flight Attendant, and Rest period. Specifies the duty period and rest period for flight attendants.	May be applicable to RLVs in future CONOPS.
Subpart Q -- Flight Time Limitations and Rest Requirements: Domestic Operations			
121.470	Applicability.	Applies to aircraft with passenger seating of 30 seats or fewer and payload capacity of 7,500 pounds or less.	Not applicable to RLVs.
121.471	Flight time limitations and rest requirements: All flight crewmembers.	Specifies the limitations for crewmembers to be not more than 100 hrs in a 30 day period among other monthly requirements and quarterly flying requirements.	Not applicable to RLVs.
Subpart R -- Flight Time Limitations: Flag Operations.			
121.480	Applicability.	Applies to aircraft with passenger seating of 30 seats or fewer and payload capacity of 7,500 pounds or less.	Not applicable to RLVs directly. Of course RLV pilots and crew will have rest requirements pertinent to space flight.
121.481	Flight time limitations: One	Specifies that a cert holder may have a crew of one or two pilots for eight hours	Not applicable to RLVs.

Section	Title	Summary of Part	Notes/RLV Questions
	or two pilot crews.	or less during any 24 consecutive hours without a rest period. Must schedule a rest period that is twice the number of hours flown since preceding rest period. Further specifies maximum flight times	
121.483	Flight time limitations: Two pilots and one additional flight crewmember.	Provides specific guidance on the flight time and rest time for two pilots and one additional crewmember.	Not applicable to RLVs.
121.485	Flight time limitations: Three or more pilots and an additional flight crewmember.	Provides specific guidance on the flight time and rest time for three or more pilots and one additional crewmember.	Not applicable to RLVs.
121.487	Flight time limitations: Pilots not regularly assigned.	Specifies flight time and rest for pilots not regularly assigned.	Not applicable to RLVs.
121.489	Flight time limitations: Other commercial flying.	No pilot may exceed the specified flight hours between carriers.	Not applicable to RLVs.
121.491	Flight time limitations: Deadhead transportation.	Time spent in deadhead transportation to or from duty is not part of a rest period.	Not applicable to RLVs.
121.493	Flight time limitations:	Specifies that the Time limitations from 121.483 apply to flight engineers and	Not applicable to RLVs.

Section	Title	Summary of Part	Notes/RLV Questions
	Flight engineers and flight navigators.	flight navigators when they are required.	
Subpart S -- Flight Time Limitations: Supplemental Operations			
121.500	Applicability.	Prescribes flight time and rest reqs for supplemental ops except for 30 passengers and fewer and 7500 pounds or less payload.	Not applicable to RLVs.
121.503	Flight time limitations: Pilots: airplanes.	Specifies that a cert holder may fly one pilot for eight hours or less during any 24 consecutive hours without a rest period. Must schedule a rest period that is twice the number of hours flown since preceding rest period. Further specifies maximum flight times.	Not applicable to RLVs.
121.505	Flight time limitations: Two pilot crews: airplanes.	Specifies that a cert holder may have a crew of two pilots for eight hours or less during any 24 consecutive hours without a rest period. Must schedule a rest period that is twice the number of hours flown since preceding rest period. Further specifies maximum flight times.	Not applicable to RLVs.
121.507	Flight time limitations: Three pilot crews: airplanes.	No pilot may be scheduled for more than 8 hours on the flight deck in any 24 hour period, nor be aloft more than 12 hours in a 24 hour period.	Not applicable to RLVs.
121.509	Flight time limitations: Four pilot crews:	No pilot may be scheduled for more than 8 hours on the flight deck in any 24 hour period, nor be aloft more than 16 hours in a 24 hour period. And no pilot	Not applicable to RLVs.

Section	Title	Summary of Part	Notes/RLV Questions
	airplanes.	may be on duty for more than 20 hours in a 24 hour period.	
121.511	Flight time limitations: Flight engineers: airplanes.	Specifies that a cert holder may fly one flight engineer for eight hours or less during any 24 consecutive hours without a rest period. Must schedule a rest period that is twice the number of hours flown since preceding rest period. Not applicable to RLVs. Further specifies maximum flight times. As well as those specified in 121.505.	Not applicable to RLVs.
121.513	Flight time limitations: Overseas and international operations: airplanes.	For supplemental ops a cert holder may choose to follow 121.515, 121.521 through 121.525 for overseas and international flights.	Not applicable to RLVs.
121.515	Flight time limitations: All airmen: airplanes.	No airman may be aloft as flight crew more than 1,000 hours in any 12 calendar month period.	Not applicable to RLVs.
121.517	Flight time limitations: Other commercial flying: airplanes.	No combined flying between commercial carriers may exceed the flight limits in this part.	Not applicable to RLVs.
121.519	Flight time limitations: Deadhead transportation: airplanes.	Time spent in deadhead is not rest time.	Not applicable to RLVs.

Section	Title	Summary of Part	Notes/RLV Questions
121.521	Flight time limitations: Crew of two pilots and one additional airman as required.	Provides specific guidance on the flight time and rest time for two pilots and one additional crewmember.	Not applicable to RLVs.
121.523	Flight time limitations: Crew of three or more pilots and additional airmen as required.	Provides specific guidance on the flight time and rest time for three or more pilots and one additional crewmember.	Not applicable to RLVs.
121.525	Flight time limitations: Pilots serving in more than one kind of flight crew.	No pilot may exceed the specified flight hours between varying flight crews	Not applicable to RLVs.
Subpart T -- Flight Operations			
121.531	Applicability.	.	
121.533	Responsibility for operational control: Domestic operations.	Certificate holder (read owner) is responsible for operational control and pilot in command and aircraft dispatcher are jointly responsible for the preflight planning, delay, and dispatch release of a flight. Additionally, the Pilot – during flight, is responsible for safety of passengers, crewmember, cargo and airplane and the pilot has full control and authority in the operation of	Applicable with modifications that reflect RLV CONOPS/personnel titles

Section	Title	Summary of Part	Notes/RLV Questions
		the aircraft without limitations. Dispatcher – 1) monitors the progress of the flight; 2) issues necessary information for the safey of the flight; and 3) cancels flight if in his opinion, or the opinion of the pilot, the flight cannot continue safely as planned	
121.535	Responsibility for operational control: Flag operations.	Certificate holder (read owner) is responsible for operational control and pilot in command and aircraft dispatcher are jointly responsible for the preflight planning, delay, and dispatch release of a flight. Additionally, the Pilot – during flight, is responsible for safety of passengers, crewmember, cargo and airplane and the pilot has full control and authority in the operation of the aircraft without limitations. Dispatcher – 1) monitors the progress of the flight; 2) issues necessary information for the safety of the flight; and 3) cancels flight if in his opinion, or the opinion of the pilot, the flight cannot continue safely as planned	Applicable with modifications that reflect RLV CONOPS/personnel titles
121.537	Responsibility for operational control: Supplemental operations.	Same as 121.533&121.535, for pilot and certificate holder, but instead of a dispatcher they reference a director of operations. Include monitoring or flight progress, maintenance and mechanical delays and any know conditions that may adversely affect the safety of flight	Applicable with modifications that reflect RLV CONOPS/personnel titles

Section	Title	Summary of Part	Notes/RLV Questions
121.538	Aircraft security.	.REF: 49 CFR chapter XII	Applicable with modifications.
121.539	Operations notices.	Certificate holder must notify its operations personnel of each change in equipment and operating procedures	Applicable with modifications.
121.541	Operations schedules: Domestic and flag operations.	Certificate holders establish flight schedules and shall allow enough time for servicing at intermediate stops taking into account prevailing winds enroute and cruising speed this speed cannot exceed the engine rated speed	Applicable with modifications.
121.542	Flight crewmember duties.	Crewmembers man not perform any duties during critical phase of flight except those duties required for the safe operation of the aircraft. Critical phases of flight include: all ground operations involving taxi, takeoff and landing and all other flight operations conducted below 10,000 feet except cruise flight	Applicable with modifications.
121.543	Flight crewmembers at controls.	.remain at duty station with seat belt fastened during taking off, landing and enroute (i.e. at all times) unless duty requires, nature requires, or a person is relieved for a break– who can be a "relief"	Applicable with modifications.-- the definition of who qualifies as a relief is the applicable portion of this
121.545	Manipulation of controls.	Only by qualified pilot or a pilot safety rep of the NTSB who has permission of the pilot in command, is qualified on the craft, and is checking flight ops	Applicable with modifications.
121.547	Admission to flight deck.	Must be authorized by the pilot and the certificate holder and the Administrator – or by pilot only in the case of safety –	Applicable with modifications.

Section	Title	Summary of Part	Notes/RLV Questions
		also the definition of who may even be authorized is included	
121.548	Aviation safety inspector's credentials: Admission to pilot's compartment.	Inspector access to pilot's compartment	Applicable with modifications.
121.549	Flying equipment.	aeronautical charts, navigation aids, instrument approach procedures, and a flashlight	Applicable with modifications – different list
121.550	Secret Service Agents: Admission to flight deck.	Automatically authorized with proper credentials	Applicable with modifications.
121.551	Restriction or suspension of operation: Domestic and flag operations.	Certificate holder must restrict or suspend operations if conditions, including airport and runway conditions, are a hazard to safe operations	Applicable with modifications.
121.553	Restriction or suspension of operation: Supplemental operations.	Same as 551 except additional responsibility: pilot in command	Applicable with modifications.
121.555	Compliance with approved routes and limitations: Domestic and flag operations.	Must stay in the routes/route segments that are specified in the certificate holder's operations spec	Applicable with modifications – routes will most likely be replaced with flight azimuth
121.557	Emergencies:	May deviate from prescribed operations	Applicable with modifications.

Section	Title	Summary of Part	Notes/RLV Questions
	Domestic and flag operations.	procedures and methods, weather minimums, and this chapter to the extent required for safety Also included is real-time and post event reporting requirements	
121.559	Emergencies: Supplemental operations.	May deviate from prescribed operations procedures and methods, weather minimums, and this chapter to the extent required for safety Also included is real-time and post event reporting requirements	Applicable with modifications.
121.561	Reporting potentially hazardous meteorological conditions and irregularities of ground and navigation facilities.	Report those things that are essential to the safety of other flights –to appropriate ground station and ground station reports to facility operator	Applicable with modifications.-- but it does not define “those things”
121.563	Reporting mechanical irregularities.	Enter in the maintenance log of the airplane at the end of that flight time and before each flight the pilot will check status	Applicable with modifications.
121.565	Engine inoperative: Landing; reporting.	Lose an engine, land ASAP unless it is one of three or more and then the pilot may choose an alternate airport based on certain considerations– this paragraph gives guidance on the types of things to consider when making that decision	Applicable with modifications.
121.567	Instrument	Follow the minimums	Applicable with modifications.

Section	Title	Summary of Part	Notes/RLV Questions
	approach procedures and IFR landing minimums.		
121.569	Equipment interchange: Domestic and flag operations.	Requirements to show that the “interchanged equipment” is appropriate	Applicable with modifications.
121.570	Airplane evacuation capability.	Must have at least one floor-level exit for the egress of passengers through normal or emergency means before the airplane can move.	Passenger
121.571	Briefing passengers before takeoff.	Specifics what must be briefed	Passenger
121.573	Briefing passengers: Extended over water operations.	Additions due to over water operations	Passenger
121.574	Oxygen for medical use by passengers.	The equipment has to be provided for the passenger by the certificate holder – the specifics of the type of container, etc, that is allowed is highlighted - this is not related to the “first-aid” oxygen	Passenger
121.575	Alcoholic beverages.	Only certificate-holder provided alcohol may be consumed, cannot serve to someone intoxicated (can’t even let intoxicated people board), someone with access to a weapon, or an escort/escortee- must report any incidents within 5 days	Passenger

Section	Title	Summary of Part	Notes/RLV Questions
121.576	Retention of items of mass in passenger and crew compartments.	Secure baggage and galley equipment when not in use	Applicable with modifications.
121.577	Stowage of food, beverage, and passenger service equipment during airplane movement on the surface, takeoff, and landing.	Stow during any movement	Passenger
121.578	Cabin ozone concentration.	Ozone specification defined per flight level	Applicable with modifications.
121.579	Minimum altitudes for use of auto-pilot.	Rules associated with when autopilot can be used – more than altitude based	Applicable with modifications.
121.580	Prohibition on interference with crewmembers.	Cannot assault, threaten, intimidate, or interfere with a crewmember	Passenger
121.581	Observer's seat: En route inspections.	Must provide a seat on the flight deck – or minimally a forward passenger seat with headset	May be applicable with modifications that reflect RLV CONOPS/personnel titles – however, the concept of “passenger” is evident
121.583	Carriage of persons	Defines who can be carried that does not have to meet requirements	Passenger

Section	Title	Summary of Part	Notes/RLV Questions
	without compliance with the passenger-carrying requirements of this part.		
121.585	Exit seating.	Exit seat is defined and who can sit there is described	Passenger
121.586	Authority to refuse transportation.	As it relates to one who may need the assistance of another person to move expeditiously to the exit	Passenger
121.587	Closing and locking of flight crew compartment door.	Shall be closed and locked except when it is necessary to permit access and egress by persons authorized IAW 121.547	Applicable with modifications that reflect RLV CONOPS/personnel titles
121.589	Carry-on baggage.	Size, amount, stowed before entry doors closed – where it may be stowed	Passenger
121.590	Use of certificated land airports.	Airplanes designed to carry 31+ passengers must land at airports certified under part 139 for less than 31 passengers	Applicable with modifications that reflect RLV CONOPS -- it lists those things that are required to be “adequate” – but not what determines adequacy
Subpart U -- Dispatching and Flight Release Rules			
121.591	Applicability.	For domestic/flag operations and flight release rules for supplemental operations	
121.593	Dispatching authority: Domestic operations.	One hour max at an intermediate airport before redispatch	Applicable with modifications that reflect RLV CONOPS/personnel titles

Section	Title	Summary of Part	Notes/RLV Questions
121.595	Dispatching authority: Flag operations.	Six hours max before redispatch	Applicable with modifications that reflect RLV CONOPS/personnel titles
121.597	Flight release authority: Supplemental operations.	Again a six hour maximum; however, there is also additional information about who can start a supplemental flight	Applicable with modifications that reflect RLV CONOPS/personnel titles
121.599	Familiarity with weather conditions.	Domestic and flag operations require that the dispatcher know the weather on the route to be flown, and the supplemental operations require it of the pilot	Applicable with modifications that reflect RLV CONOPS/personnel titles
121.601	Aircraft dispatcher information to pilot in command: Domestic and flag operations.	Navigation facilities, weather reports and forecasts, - specifics of the weather are called out here,	Applicable with modifications that reflect RLV CONOPS/personnel titles
121.603	Facilities and services: Supplemental operations.	Pilot must obtain the information on airport conditions and navigation facilities and weather.	Applicable with modifications that reflect RLV CONOPS/personnel titles
121.605	Airplane equipment.	“No person may dispatch or release an airplane unless it is airworthy and is equipped as prescribed in 121.202”	Applicable with modifications that reflect RLV CONOPS/personnel titles
121.607	Communication and navigation facilities: Domestic and flag operations.	Required prior to flight and IAW 121.99 and 121.103 unless the pilot find and equivalent outside the US	Applicable with modifications that reflect RLV CONOPS

Section	Title	Summary of Part	Notes/RLV Questions
121.609	Communication and navigation facilities: Supplemental operations.	Same as 607 but no equivalent statement	Applicable with modifications that reflect RLV CONOPS – always need equivalency statement
121.611	Dispatch or flight release under VFR.	Must ensure that ceiling and visibility en route (both actual and forecasted) will remain at or above minimums	Applicable with modifications that reflect RLV CONOPS
121.613	Dispatch or flight release under IFR or over the top.	Must ensure that ceiling and visibility en route (both actual and forecasted) will remain at or above minimums	Applicable with modifications that reflect RLV CONOPS
121.615	Dispatch or flight release over water: Flag and supplemental operations.	Same as 121.611 plus some specifics about Alaska.	Applicable with modifications that reflect RLV CONOPS
121.617	Alternate airport for departure.	This refers to the return to airport criteria and highlights the alternate airport distances allowed.	Applicable with modifications that reflect RLV CONOPS
121.619	Alternate airport for destination: IFR or over-the-top: Domestic operations.	Identifies ceiling and visibility requirements and number of alternate airports required under what circumstances.	Applicable with modifications that reflect RLV CONOPS
121.621	Alternate airport for destination:	Identifies ceiling and visibility requirements and number of alternate airports required under what	Applicable with modifications that reflect RLV CONOPS

Section	Title	Summary of Part	Notes/RLV Questions
	Flag operations.	circumstances.	
121.623	Alternate airport for destination: IFR or over-the-top: Supplemental operations.	At least one airport for each destination in the flight release. Except where the aircraft carries enough fuel to meet the requirements of 121.643and 121.645	Applicable with modifications that reflect RLV CONOPS
121.625	Alternate airport weather minimums.	Reports and forecasts must match the weather minimums specified in the certificate holder's specifications for that airport	Applicable with modifications that reflect RLV CONOPS
121.627	Continuing flight in unsafe conditions.	Follow the owner's manual in the event of an equipment failure. Implement an emergency situation landing procedure if the pilot feels that it is unsafe to continue the flight	Applicable with modifications that reflect RLV CONOPS
121.628	Inoperable instruments and equipment.	Cannot takeoff with inoperable instruments or equipment unless certain conditions are met (e.g. an approved MEL exists)	Applicable with modifications that reflect RLV CONOPS
121.629	Operation in icing conditions.	No dispatch, takeoff, continue enroute, or land where icing condition are expected or are already there. Except for example, an approved ground deicing/anti-icing programs- some of the parameters of approval are highlighted in this paragraph	Applicable with modifications that reflect RLV CONOPS
121.631	Original dispatch or flight release,	Based on type of aircraft, weather, and amount of fuel.	Applicable with modifications that reflect RLV CONOPS

Section	Title	Summary of Part	Notes/RLV Questions
	redispatch or amendment of dispatch or flight release.		
121.633	[Reserved]	.	
121.635	Dispatch to and from refueling or provisional airports: Domestic and flag operations.	Reference “regular” airport requirements.	Applicable with modifications that reflect RLV CONOPS
121.637	Takeoffs from unlisted and alternate airports: Domestic and flag operations.	References for weather minimums and conditions under which a pilot may use unlisted airports.	Applicable with modifications that reflect RLV CONOPS
121.639	Fuel supply: All domestic operations.	Defines “enough fuel”	Applicable with modifications that reflect RLV CONOPS
121.641	Fuel supply: Non-turbine and turbo-propeller-powered airplanes: Flag operations.	Defines “enough fuel”	turbo-propeller-powered
121.643	Fuel supply: Non-turbine and turbo-propeller-	Defines “enough fuel”	turbo-propeller-powered

Section	Title	Summary of Part	Notes/RLV Questions
	powered airplanes: Supplemental operations.		
121.645	Fuel supply: Turbine-engine powered airplanes, other than turbo propeller: Flag and supplemental operations.	Defines “enough fuel”	turbo-propeller-powered
121.647	Factors for computing fuel required.	Following factors must be considered in the computations: wind and other weather conditions forecast anticipated traffic delays one instrument approach and possible missed approach at destination any other potential delaying conditions	Applicable with modifications that reflect RLV CONOPS
121.649	Takeoff and landing weather minimums: VFR: Domestic operations.	Additional ceiling and visibility requirements.	Applicable with modifications that reflect RLV CONOPS
121.651	Takeoff and landing weather minimums:	Certificate holders specifications or if not there, parts 91 and 97 are the default requirements. Also, this includes visual reference indicators (e.g. runway	Applicable with modifications that reflect RLV CONOPS

Section	Title	Summary of Part	Notes/RLV Questions
	IFR: All certificate holders.	lights)	
121.652	Landing weather minimums: IFR: All certificate holders.	There are some caveats here base on the experience of the pilot: if less than 100 hours as a pilot in command it is more restrictive/dictated.	Applicable with modifications that reflect RLV CONOPS
121.653	[Reserved]		
121.655	Applicability of reported weather minimums.	Latest oral report from the control tower overrides that “weather report”	Applicable
121.657	Flight altitude rules.	Minimum “in flight” altitudes, with details of exceptions for minimum en route IFR altitudes	Applicable with modifications that reflect RLV CONOPS
121.659	Initial approach altitude: Domestic and supplemental operations.	Cannot go below minimum altitude until arrival over that facility has been definitely established. Additionally, information on threshold markings, etc. is provided here.	Applicable with modifications that reflect RLV CONOPS
121.661	Initial approach altitude: Flag operations.	Arrival at facility must be definitely established	Applicable with modifications that reflect RLV CONOPS
121.663	Responsibility for dispatch release: Domestic and flag operations.	Flight release must be signed by both the dispatcher and by the pilot in command	Applicable with modifications that reflect RLV CONOPS/personnel titles

Section	Title	Summary of Part	Notes/RLV Questions
121.665	Load manifest.	Certificate holder employees must prepare and sign this form before each takeoff	Applicable with modifications that reflect RLV CONOPS
121.667	Flight plan: VFR and IFR: Supplemental operations.	Flight plans must be filed before takeoff unless the communication facilities are not readily available; then as soon as possible after in the air.	Applicable with modifications that reflect RLV CONOPS
Subpart V -- Records and Reports			
121.681	Applicability.	All certificate holders	
121.683	Crewmember and dispatcher record.	References proficiency and route checks, airplane and route qualifications, training, any required physical examinations, flight duty and rest time records.	Applicable with modifications that reflect RLV CONOPS/personnel titles
121.685	Aircraft record: Domestic and flag operations.	Certificate holder must supply the district office with a current list of each aircraft that it operates in scheduled air transportation (including any interchange agreement aircraft)	Applicable with modifications that reflect RLV CONOPS
121.687	Dispatch release: Flag and domestic operations.	Must contain the ID number of the aircraft, the trip number, the departure airport, intermediate stops, destination airports, and alternate airports, a statement of the type of operation (e.g. IFR, VFR) minimum fuel supply and weather reports/forecasts for all airports of interest.	Applicable with modifications that reflect RLV CONOPS
121.689	Flight release form: Supplemental operations.	Company, make/model/registration number of the aircraft, flight/trip number and date of flight,, name of each crewmember, departure airport,	Applicable with modifications that reflect RLV CONOPS

Section	Title	Summary of Part	Notes/RLV Questions
		destination airports, alternate airports, and route, minimum fuel supply, type of operation, and weather reports.	
121.691	[Reserved]		
121.693	Load manifest: All certificate holders.	Total weight, max allowable takeoff weight, assurance that the aircraft was loaded wrt the cg, names of passengers	Applicable with modifications that reflect RLV CONOPS
121.695	Disposition of load manifest, dispatch release, and flight plans: Domestic and flag operations.	Pilot carries a copy of these. Also, copies of all of these are kept for three months at the principal base of operations.	Applicable with modifications that reflect RLV CONOPS
121.697	Disposition of load manifest, flight release, and flight plans: Supplemental operations.	In addition to these, the pilot carries a copy of the Airworthiness release and pilot route certification – Also, copies of all of these are kept for three months at the principal base of operations.	Applicable with modifications that reflect RLV CONOPS
121.698-121.699	[Reserved]		
121.701	Maintenance log: Aircraft.	Anything that is done that is critical to the safety of flight shall be recorded in the maintenance log. Copies of this log shall be maintained on-board the aircraft.	Applicable with modifications that reflect RLV CONOPS
121.703	Mechanical reliability reports.	This references an amendment that was delayed until Jan 16, 2003.	Applicable with modifications that reflect RLV CONOPS
121.704	Service difficulty	This references an amendment that was delayed until Jan 16, 2003.	Applicable with modifications that reflect RLV CONOPS

Section	Title	Summary of Part	Notes/RLV Questions
	reports (structural).		
121.705	Mechanical interruption summary report.	This references an amendment that was delayed until Jan 16, 2003.	Applicable with modifications that reflect RLV CONOPS
121.707	Alteration and repair reports.	Major repairs/alterations of the following must be reported to the Administrator: airframe, aircraft engine, propeller, or appliance of an aircraft operated by it.	Applicable with modifications that reflect RLV CONOPS
121.709	Airworthiness release or aircraft log entry.	Amended at 66 FR 41116, August 6,2001	Applicable with modifications that reflect RLV CONOPS
121.711	Communicatio n records: Domestic and flag operations.	Each certificate holder shall record each en route radio contact between the certificate holder and its pilots and shall keep that record for at least 30 days.	Applicable with modifications that reflect RLV CONOPS
121.713	Retention of contracts and amendments: Commercial operators who conduct intrastate operations for compensation or hire.	Archive time periods plus financial reporting requirements.	Applicable with modifications that reflect RLV CONOPS
Subpart W -- Crewmember Certificate: International			
121.721	Applicability.	US citizens as crewmembers on international flights	
121.723	Surrender of	Surrender upon termination of	Applicable with modifications that

Section	Title	Summary of Part	Notes/RLV Questions
	international crewmember certificate.	employment	reflect RLV CONOPS/personnel titles
		Subpart X – Emergency Medical Equipment and Training.	
		All certificate holders operating passenger-carrying airplanes ----NOT intended to require certificate holders or its agents to provide emergency medical care or to establish a standard of care for the provision of emergency medical care.	These two statements contradict one another
		Appendix A now, plus an approved automated external defibrillator as of April 12, 2004.	Applicable with modifications that reflect RLV CONOPS
		All crewmembers to an overview level, flight attendance requirements are much more and include performance drills	Applicable with modifications that reflect RLV CONOPS/personnel titles
Appendix A to Part 121 --	First-Aid Kits and Emergency Medical Kits	Basically an MEL for first aid kit	Applicable with modifications that reflect RLV CONOPS
Appendix B to Part 121 --	Aircraft Flight Recorder Specifications	Parameters to record plus the associated tolerance	Applicable with modifications that reflect RLV CONOPS
Appendix C to Part 121	-- C-46 Non-transport Category Airplanes	Modification/compliance of requirements as they pertain to the C-46 operation plus takeoff limitations, enroute limitations	Specific to C-46
Appendix D to Part 121 --	Criteria for Demonstration	Aborted takeoff demonstration and a ditching demonstration are required.	Applicable with modifications that reflect RLV CONOPS/personnel

Section	Title	Summary of Part	Notes/RLV Questions
	of Emergency Evacuation Procedures Under §121.291		titles
Appendix E to Part 121	-- Flight Training Requirements	Initial, transition and upgrade training checklist – includes items of performance and evaluation scenarios	Applicable with modifications that reflect RLV CONOPS/personnel titles
Appendix F to Part 121 --	Proficiency Check Requirements	Maneuvers and procedures checklist - includes items of performance and evaluation scenarios	Applicable with modifications that reflect RLV CONOPS/personnel titles
Appendix G to Part 121 --	Doppler Radar and Inertial Navigation System (INS): Request for Evaluation; Equipment and Equipment Installation; Training Program; Equipment Accuracy and Reliability; Evaluation Program	What is required in the application, general guidance, high level requirements, training program, reliability criteria, evaluation criteria	Applicable with modifications that reflect RLV CONOPS/equipment types
Appendix H to Part 121 --	Advanced Simulation	Advanced simulator approval, changes to simulator programming, simulator MEL, advanced simulation training program, simulator and visual requirements for different rated levels	Applicable with modifications that reflect RLV CONOPS/personnel titles

Section	Title	Summary of Part	Notes/RLV Questions
Appendix I to Part 121 --	Drug Testing Program	Who, what , when, why, how, and repercussions of positive results	Applicable with modifications that reflect RLV CONOPS/personnel titles
Appendix J to Part 121 --	Alcohol Misuse Prevention Program	Note: this includes testing also --Who, what , when, why, how, and repercussions of positive results	Applicable with modifications that reflect RLV CONOPS/personnel titles
Appendix K to Part 121 --	Performance Requirements for Certain Turbopropeller Powered Airplanes	Design	Design
Appendix L to Part 121 --	Type Certification Regulations Made Previously Effective	OLD	N/A
Appendix M to Part 121 --	Airplane Flight Recorder Specifications	Parameters and tolerance requirements	Applicable with modifications that reflect RLV CONOPS/equipment

14 CFR 142 Training Centers

Effective Date	10/18/2002
Contents and review purpose	This FAR contains requirements for a variety of training facilities overseen by the FAA. It was reviewed to determine which items might be appropriate for training of O&M personnel involved with RLVs.

Section	Title	Summary of Part	Notes/RLV Questions
Subpart A - General			
142.1	Applicability	States that this part provides an alternative to training requirements found in parts 61, 63, 121, 125, 135, and 137. Makes a number of provisions for special cases (e.g. a part 121 operator training another part 121 operator), and states that no training is allowed outside this FAR for advanced flight training after August 3, 1998.	The last item is particularly troubling for RLV and commercial space in general. As written, this FAR already applies to commercial space. One way of alleviating this problem is to rework the definitions of flight and aircraft within the space-related rules.
142.3	Definitions	Provides detailed definitions for advanced flight training devices, core curriculum, course, courseware, evaluator, flight training equipment, instructor, line-operational simulation, specialty curriculum, training center, training program, and training specifications.	Many problems similar to those found in part 1 – aircraft, flight, certification, and air traffic control. The specialty curriculum provides a way to make this part workable for RLVs and commercial space as a whole.

Section	Title	Summary of Part	Notes/RLV Questions
142.5	Certificate and Training Specifications Required	States that no person can operate a training center without appropriate approvals.	Will need to establish the approval criteria for RLV-related training and training centers.
142.7	Duration of a Certificate	Domestic – indefinite as long as approval criteria continues to be met Foreign – automatic expiration at the end of 12 months unless reapplied for Certificate must be return within five days if suspended, revoked, or terminated	OK
142.9	Deviations or Waivers	Deviations and waivers possible for any elements of this part following provision of acceptable justification showing instruction will not be adversely affected	OK
142.11	Application for Issuance of an Amendment	Provides detailed list of application contents including who will train, where training will be conducted, what will be trained, how this part will be met, etc. States the application will go to the FSDO for the geographic region in which the training center is to be located. Also provides application contents for amendments to existing training.	Generally OK with exception of FSDO involvement. Issues of intra-agency coordination need to be addressed.
142.13	Management and Personnel Requirements	Very general statements regarding the assurance of “adequate” numbers of instructors, evaluators, and management personnel.	OK

Section	Title	Summary of Part	Notes/RLV Questions
142.15	Facilities	States general requirements for facilities including heating, ventilation, light, free of disruptive noise (e.g. flight operations), and adequate training equipment including at least one flight simulator or advanced flight training device. Also requires office of record and associated records to be available at training site.	OK – although AST will need to determine what constitutes a flight simulator or advanced flight training device for a RLV. This will almost ensuredly be defined by the RLV OEM, at least initially.
142.17	Satellite Training Centers	Satellite training centers are allowed provided they are under the management of the principal facility, proper notification has been provided, and the location information is made available to the FAA.	OK
142.21 – 142.25	Reserved	N/A	N/A
142.27	Display of Certificate	Certificate must be on display and relevant data must be available for inspection by the FAA, NTSB, or other law enforcement.	OK
142.29	Inspections	Inspections by the FAA must be allowed	OK
142.31	Advertising Limitations	Can’t advertise what you are not approved for. If approval is lost for any reason, must take immediate action to remove all advertising indicating administrator approval	OK

Section	Title	Summary of Part	Notes/RLV Questions
142.33	Training Agreements	Establishes the ways in which pilot schools certificated under part 141 can work with and through part 142 training centers.	OK – need to review part 141.
Subpart B – Aircrew Curriculum and Syllabus Requirements			
142.35	Applicability	States the scope of this subpart is limited to established curriculum and course syllabi contents to training centers in order to satisfy part 61	OK – real question is what of part 61 applies?
142.37	Approval of Flight Aircrew Training Program	States all training programs must be approved and then provided application criteria. Notes that training programs approved under SFAR 58 in part 121 are approved for 142 without any further showing. Notes that if the administrator finds problems subsequent to approval, the administrator has the authority to require changes.	OK – again the issue is really in part 61 and in this case, also SFAR 58 of 121
142.39	Training Program Curriculum Requirements	Lists the curriculum requirements including provision of syllabus, required training equipment, qualifications for instructors, qualifications of evaluators, currency requirements for both instructors and evaluators, and the means for evaluating student performance.	OK – again a direct linkage to part 61
Subpart C – Personnel and Flight Training Equipment Requirements			
142.45	Applicability	This subpart applies only to equipment used to satisfy part 61 requirements	OK – link to 61

Section	Title	Summary of Part	Notes/RLV Questions
142.47	Training Center Instructor Eligibility Requirements	Instructors must be at least 18 years of age, fluent in written and spoken English, hold appropriate flight qualifications, meet appropriate elements of part 61, and have minimum education in enumerated training techniques.	OK – link to 61
142.49	Training Center Instructor and Evaluator Privileges and Limitations	Enumerates what instructors and evaluators can and cannot do including operating within compliance to both this part and part 61. Also places limits on number of hours of instruction in a 24-hour period.	Ok – link to 61
142.51	Reserved	N/A	N/A
142.53	Training Center Instructor Training and Testing Requirements	Enumerates the recurrent evaluation criteria for instructors: covers the subjects that instructor is designated to teach, teaching methods, emergency issues, and flight ratings as appropriate. Allows for credit to be given against this part if the instructor has already satisfied part 121 or part 135 requirements as they relate to recurrent training and evaluation of instructors	OK
142.55	Training Center Evaluator Requirements	Enumerates the criteria for evaluators including currency requirements. Allows for approval of evaluators under the Advanced Qualification Program (SFAR 58) in lieu of this part.	OK – related to 121

Section	Title	Summary of Part	Notes/RLV Questions
142.57	Aircraft Requirements	Enumerates requirements for aircraft used in training programs including standard airworthiness certificates, established maintenance procedures, and operating procedures in compliance with part 91. Discusses specific aircraft systems that must be present in any training aircraft.	Highly problematic – will need a corresponding, preferably more general format for RLVs.
142.59	Flight Simulators and Flight Training Devices	Wide range of requirements covering simulator and flight training device composition and operation.	Highly problematic – references specific systems and uses traditional aviation language only.
Subpart D – Operating Rules			
142.61	Applicability	This subpart is limited to training centers discussed within this part and approved in accordance with subpart B.	OK
142.63	Privileges	Allows the use of simulators and flight training devices to be used by instructors and evaluators for the purposes of maintaining their currency. Must meet subpart B requirements and be approved under Advanced Qualification Program.	OK
142.65	Limitations	Discusses two areas of limitation: the first relates to the features used as part of a simulator or flight training device. The second is on when a trainee may be recommended for certification.	Rules appear to be straightforward, however language will be problematic for RLV operations.
Subpart E - Record keeping			

Section	Title	Summary of Part	Notes/RLV Questions
142.71	Applicability	This subpart covers record keeping for the trainees, as well both instructors and evaluators.	OK
142.73	Record keeping Requirements	This rule enumerates the contents of the records and the retention periods for the records. Also establishes requirement for providing the trainee or the administrator with copies of records in a timely fashion.	OK
Subpart F – Other Approved Courses			
142.81	Conduct of Other Approved Courses	Allows an applicant to request approval of training for topics other than those covered in this subpart and for personnel other than flight crew including material handlers, ground service personnel, and security personnel.	OK – provides an out for accomplishing whatever RLV training is deemed appropriate under this rule without making any other changes. In other words, it eliminates the problem of scope and applicability found in subpart A of this part.

14 CFR 185 Testimony by Employees and Production of Records in Legal Proceedings, and Service of Legal Process and Pleadings

Effective Date	10/18/02
Contents and review purpose	This is an administrative rule related to legal proceedings. This rule was reviewed for applicability to RLVs.

Subpart A - General			
Section	Title	Summary of Part	Notes/RLV Questions
185.1	Purpose	To name the FAA officials who may be served in any legal proceedings concerning the FAA and those who may perform functions as prescribed in legal proceedings.	RLV regulations also need similar points of contact and rules for legal proceedings.
185.3	Acceptance of Service on Behalf of the Secretary of Transportation or the Administrator	Chief counsel or a person designated by the chief counsel may be served - same effect as if served upon the secretary of transportation or the administrator.	The same contact namely the chief counsel for the FAA may be used for AST matters.
185.5	Testimony by Employees and Production of Records on Legal Proceedings	Chief counsel and other employee responsibilities	Applicable to RLVs also

14 CFR 187 Fees

Effective Date	10/18/2002
Contents and review purpose	This FAR contains the administrative procedures for establishing and collecting fees. This FAR was reviewed to gain an understanding of how the fees system works for the purposes of identifying possible approaches for fees use for RLVs.

Section	Title	Summary of Part	Notes/RLV Questions
187.1	Scope	This part covers only those fees not cover elsewhere in 14 CFR or 49 CFR part 7.	Need to verify that fees for other 400-series rules are described locally within the constituent part.
187.5	Duplicates of Licenses	Fees for getting a duplicate certificate is $2.	Quite a bargain – cannot possibly reflect the true cost of labor involved to retrieve, copy, and transmit. Is this covered in the RLV licensing part?
187.7	Copies; Seal	Points to subpart H of 49 CFR part 7 for this fee.	Unlikely that a change would be required here.
187.15	Payment of Fees	Form of payment; requirement to pay all associated bank fees; and, in the case of fees covered in Appendix B of this part, payments in excess of $1000 USD must be via electronic funds transfer.	No need for a change
187.17	Failure of Applicant to Pay Prescribed Fees	Failure to pay allows the FAA to deny or suspend any service OR revoke any “production certification-related approval granted.”	Definite problem. If a launch license has been granted, this paragraph as written does not allow the FAA to rescind that license for non-payment. Current commercial space rules do not

Section	Title	Summary of Part	Notes/RLV Questions
			contain a production approval or any form of certification approval.
Appendix A	Methodology for Computation of Fees for Certification Services Performed Outside the United States	Provides a detailed formula for calculation of costs associated with overseas certification work. Key components include all charges based on labor rate for Aviation Safety Inspector (ASI) and service will be accomplished through the Flight Standards Service.	Needs to be reconsidered/rewritten for launch licensing. Who would accomplish the work; from what part of the agency will that individual(s) come from;, will the FAA even allow for this in the near-term?
Appendix B	Fees for Services for Certain Flights	Provides a detailed formula included specific rates for overflights of the United States. Canadian and government aircraft are exempt. Specifics of how and when invoices will be created and mailed are also included.	This area needs consideration. Since the FAA is creating a new position at the command center for international space coordination. Will overflight fees be one of the responsibilities? At what point (altitude) does jurisdiction end? Should there be fees associated with the de-orbit of satellites and other space debris?
Appendix C	Fees for Production Certification-Related Services Performed Outside the United States	This appendix provides the circumstances where production certification associated costs for overseas manufacturing sites will apply and how they will be computed. Specific definitions for manufacturing facility, production certification-related service, supplier facility, and production approval holder are provided.	Currently does not apply since there is no express production approval intended for RLVs. Will need to be revisited if this changes in the future.

14 CFR 193 Protection of Voluntarily Submitted Information

Effective Date	10/18/02
Contents and review purpose	This part describes how the FAA protects safety and security information voluntarily submitted to the FAA. These rules were reviewed for applicability to RLVs.

Subpart A - General			
Section	**Title**	**Summary of Part**	**Notes/RLV Questions**
193.1	What does this part cover?	Describes when and how the FAA protects safety and security data that is voluntarily submitted.	Applies to RLVs also.
193.3	Definitions	Definition of terms	No new terms were recognized as needed for RLVs.
193.5	How may I submit safety or security information and have it protected from disclosure?	Conditions of protection of data, enforcement and findings by the FAA	Applicable to RLVs.
193.7	What does it mean for the FAA to designate information as protected?	Conditions of disclosure of information, request through FOIA, case of subpoena for information.	Applicable to RLVs

193.9	Will the FAA ever disclose information that is designated as protected under this part?	Disclosure of de-identified information to promote safety and security, or in response to a criminal investigation or prosecution	Applicable to RLVs
193.11	What is the notice procedure?	Public notice of designation of protection on specific information - notice in the Federal Register.	Applicable to RLVs
193.13	What is the non-notice procedure?	Procedure used when there is not enough time for public notice procedure. i.e, there is an immediate need to protect information. 193.11 may be used in conjunction with this non-notice procedure.	Applicable to RLVs
193.15	What FAA officials exercise the authority of the Administrator under this part?	Authority given to Chief Counsel.	Applicable to RLVs
193.17	How must design and production approval holders handle information they receive from the FAA under this part?	All parties who may receive this data should protect the data with a need to know basis.	Applicable to RLVs; however there are no design or production approvals for RLVs yet.

Appendix D 14 CFR 1200 – 1299 Review

14 CFR 1200 – 1299 National Aeronautics and Space Administration

Effective Date	11/21/02
Contents and review purpose	Each of the NASA CFR parts was reviewed for lessons-learned applicable to RLV O&M.

CFR Part	Title	Summary of Part	Notes/RLV Questions
1200	[Reserved]	N/A	N/A
1201	Statement of Organization and General Information	Contains language establishing NASA including basic organization, standing boards, and field location responsibilities.	1201.102: Definition of phrase “aeronautical and space vehicles” to include aircraft, missiles, satellites, and space vehicles may be of some interest in working the terminology question for RLVs.
1203	Information Security Program	Describes the various mechanisms used for classifying and declassifying information including identification of authority, time limits, and handling of foreign data.	No direct RLV O&M Applicability
1203a	NASA Security Areas	Describes the various designations of security areas; who may be admitted to security areas; the penalties for violating a security area, and the authority for enforcement of security areas.	RLV operations may require the equivalent of a security area for certain operations such as propellant loading. The definitions for limited, restricted, closed, permanent and temporary may all be useful.

CFR Part	Title	Summary of Part	Notes/RLV Questions
1203b	Security Programs; Arrest Authority and Use of Force by NASA Security Force Personnel	Describes the arrest authority; how an arrest is to be accomplished; the use of both non-deadly and deadly force in the process of arrest; the storage of weapons used for enforcement; and the steps taken following the discharge of a weapon while on duty.	No direct RLV O&M Applicability
1204	Administrative Authority and Policy	Describes a wide variety of administrative functions including small business programs, handling of real estate, interaction with the Army Corps of Engineers, the Centennial of Flight Commission, interaction with Health, Education and Welfare Department (out of date since these departments are now separate), inspection rights and rules governing the introduction of weapons and dangerous materials to NASA facilities. There is also a section on the use of NASA airfields by non-governmental aircraft that includes requirements for hold harmless agreements, use permits, and certificates of insurance. Finally, the part concludes with a section on intergovernmental coordination, primarily with various state agencies.	RLV operations may involve the use of NASA airfields. State coordination may come into play for spaceport activities at non-NASA facilities.
1205	[Reserved]	N/A	N/A

CFR Part	Title	Summary of Part	Notes/RLV Questions
1206	Availability of Agency Records to Members of the Public	Provides the definition of agency records and the ways that the public may gain access to them. This includes detailed information on how NASA deals with FOIA requests including provision of a fee structure.	No direct RLV O&M Applicability
1207	Standards of Conduct	Provides ethical guidelines for NASA employees, particularly as it relates to conflict of interest and post-employment solicitation.	No direct RLV O&M Applicability
1208	Uniform Relocation Assistance and Property Acquisition for Federal and Federally Assisted Programs	Single subpart provides pointers to detailed information on the two title acts.	No direct RLV O&M Applicability
1209	Boards and Committees	Describes operations of two boards: the Contract Adjustment Board and the Inventions and Contributions Board.	No direct RLV O&M Applicability
1210	Development Work for Industry in NASA Wind Tunnels	Describes the wind tunnel facilities available for both government and industry projects; how the facilities may be used and how data is protected; and, the what additional resources are available before, during, and after	No direct RLV O&M Applicability – may be worth talking to the wind tunnel personnel at Ames to determine what, if any, guidelines they may have for the types of things that should be examined

CFR Part	Title	Summary of Part	Notes/RLV Questions
		scheduled wind tunnel testing.	that relate to a vehicle's operational characteristics
1211	[Reserved]	N/A	N/A
1212	Privacy Act-NASA Regulations	Describes the rules for administering the Privacy Act as it applies to personnel and medical files including both civil and criminal penalties for violations of the Act.	No direct RLV O&M Applicability
1213	Release of Information to News and Information Media	Describes mechanisms for releasing information to the media. Also states that data associated with DoD operations on the Shuttle, as well as vulnerability information associated with the Shuttle and supporting infrastructure may be classified and not subject to public release.	No direct RLV O&M Applicability
1214	Space Flight		

CFR Part	Title	Summary of Part	Notes/RLV Questions
1215	Tracking and Data Relay Satellite System (TDRSS)	Describes the services that can be provided by TDRSS; how a commercial operator can contract for these services; the fee schedules and timelines associated with the services; and, where to find additional information on TDRSS	Will need to be examined for information relating to communication, flight control, and navigation.
1216	Environmental Policy	Describes mechanisms used by NASA to comply with various environmental acts. Outlines how and when environmental impact statements are required. Also notes exclusions from EIS including most NASA R&D activities. Provides for interagency coordination on issues affecting the environment.	No direct RLV O&M Applicability
1217	Duty-free Entry of Space Articles	Provides NASA with the means of importing spacecraft, parts, or payloads duty free. Also allows NASA to bring items into the US from space duty-free.	No direct RLV O&M Applicability – perhaps there should be such an exemption for space mining as an additional incentive to the industry
1221	The NASA Seal and Other Devices, and the Congressional Space Medal of Honor	N/A	N/A
1230	Protection of Human Subjects	Deals with experimentation on human subjects.	This may not be an immediate concern for RLV regulations. The only question is whether test pilots are considered human subjects in experimentation.

CFR Part	Title	Summary of Part	Notes/RLV Questions
1232	Care and Use of Animals in the Conduct of NASA Activities	Deals with animals used NASA activities.	Do not see an immediate need unless RLV flight tests require use of animals.
1240	Inventions and Contributions	Contributions, which have significant value in space activities, may be rewarded.	There is already a regulation that covers this idea. Federal Technology Transfer Act of 1986, section 12, 15 U.S.C. 3710b(1).
1241	[Reserved]	N/A	N/A
1245	Patents and Other Intellectual Property Rights	Deals with regulations for the waiver of rights of the Government of the United States to inventions made under NASA contract	There may already be an FAA regulation similar to this rule.
1250	Nondiscrimination in Federally Assisted Programs of NASA (effectuation of Title VI of the Civil Rights Act of 1964)	Nondiscrimination on the basis of race, color or national origin	Title VI of the Civil Rights Act of 1964 is made effective by this rule. The FAA may already have this rule.

CFR Part	Title	Summary of Part	Notes/RLV Questions
1251	Nondiscrimination on Basis of Handicap	Nondiscrimination on the basis of handicap for participating in any program or activity receiving Federal financial assistance.	Effectuates section 504 of the Rehabilitation Act of 1973. The FAA may already have this rule.
1252	Nondiscrimination on the Basis of Age in Programs and Activities Receiving Federal Financial Assistance		There is a government-wide age discrimination regulations at 45 CFR part 90.
1253	Nondiscrimination on the Basis of Sex in Programs and Activities Receiving Federal Financial Assistance	Effective date was set to Sept. 29 2000!	Effectuates Title IX of the Education Amendments of 1972. The FAA may already have these regulations.
1259	National Space Grant College and Fellowship Program		

CFR Part	Title	Summary of Part	Notes/RLV Questions
1260	Grants and Cooperative Agreements	Space Grant Review Panel to review and advise the Administrator with respect to Space Grant Programs.	N/A since the FAA does not have an program to accept gifts, donations and funds to channel to institutions.
1261	Processing of Monetary Claims (general)	Deals with regulations on claims against NASA- who can make a claim, sets the maximum amount sets the rules for time limitations and allowable claims.	This is an infrastructure policy; The FAA should already have this on the books. Will become an issue if AST were to break off to be an independent agency.
1262	Equal Access to Justice Act in Agency Proceedings	Explains the award of attorney fees and other expenses in case of certain administrative proceedings.	This is also an infrastructure policy. The FAA should already have this type of a regulation.
1263	Demand for Information or Testimony Served on Agency Employees; Procedures	Procedures for disclosure of official information.	There are Administrative FARs that deal with this issue for the FAA.
1264	Implementation of the Program Fraud Civil Penalties Act of 1986	Administrative procedures for imposing civil penalties and assessments against certain fraudulent activities.	The FAA administrative FARs cover this item.

CFR Part	Title	Summary of Part	Notes/RLV Questions
1265	Government wide Debarment and Suspension (non-procurement) and government wide requirements for Drug-Free Workplace (grants)	Executive order 12549 - a government wide system for non-procurement debarment and suspension. Also under 48 CFR part 9 will include the list of parties excluded form Federal Procurement and Non-procurement programs.	This is a government-wide regulation; the FAA already has compliance requirements.
1266	Cross-waiver of Liability	To ensure that consistent cross-waivers of liability are included in NASA agreements for Space Station Freedom activities, Shuttle Launch services and NASA Expendable Launch Vehicle program launches. Article 16 of the Intergovernmental Agreement among the United States, the Governments of Member States of the European Space Agency, the Government of Japan and the Government of Canada on Co-operation in the Detailed Design, Development, Operation and Utilization of the Permanently Manned Civil Space Station" is the memorandum of understanding between international partners on Space Station Freedom. Launch activities of Space Shuttle or NASA ELVs that do not involve activities of Space Station must be cross-referenced with waiver clauses.	The model for international agreements and caveats that need to be provided when activities do not come under the international agreements should be used in the FAA RLV inter and intra agency cooperation as needed.

CFR Part	Title	Summary of Part	Notes/RLV Questions
1271	New Restrictions on Lobbying	Influencing or attempting to influence an officer or an employee of the agency or a member of congress, or employee of congress, or an employee of member of congress in connection with Federal contract, Federal grant, Federal loan, or a cooperative agreement.	The FAA administrative regulations/policy should already cover this clause. This is an agency wide issue much larger than RLV O&M.
1273	Uniform Administrative Requirements for Grants and Cooperative Agreements to State and Local Governments	Prescribes forms, and instructions to be used by governmental agencies for applying for grants.	The FAA administrative regulations/policy should already cover this clause. This is an agency wide issue much larger than RLV O&M.
1274	Cooperative Agreements with Commercial Firms	When research is conducted under a cooperative agreement, NASA has the obligation to assume responsibility for the technical performance of the outcomes and associated financial costs of research activities.	The same model should be followed by the FAA on any research activities on RLV issues. However, since this regulation applies to all cooperative activities within the agency, there may already be an agency wide administrative policy or one should be constructed for AST wide use.
1275-1299	[Reserved]	N/A	N/A

Appendix E Guideline Input Detail Sheets

The two detail sheets contained here were used for data collection during this phase of the research effort.

Generic Subsystem Guideline Input Detail

The following questions and research steps are intended to fully characterize each of the major subsystems that have been identified for RLV O&M. The current list of functions may be found in the Subsystems Breakout.

General

[Items 1 and 2 of this section are targeted for inclusion in the Supplemental Report under Data Collection – Subsystems. The remaining content will appear in the Data Synthesis section of the Supplemental Report and General Guideline Input volume.]

1. Include definition of subsystem from original report or as modified in the supplemental report.
2. Identify sources for this subsystem. Where possible, note other subsystems or functions also addressed in the source.
3. Discuss the basic types/ taxonomy of this particular subsystem (fundamental characteristics of subsystem).
4. Provide a diagram highlighting and identifying safety issues (if applicable).
5. List and define (where necessary) the major issues associated with this subsystem that may affect the public safety.
6. List any special capabilities and/or limitations of this subsystem, by type if necessary, that have a bearing on the safety issues.
7. List any inter and intra agency issues associated with this subsystem.
8. Identify pertinent FAA-AST guidelines by subsystem and function. Use a placeholder for these items.

Operations

[The items in this section will appear in both the Data Synthesis section of the Supplemental Report and the specific Guideline Inputs volume concerned with Operations.]

1. Discuss the key operating characteristics of the subsystem by type and its connections to other systems (either on the vehicle or with GSE/facilities) that may affect safety. Identify the affected sub-functions within operations (out of the 8 identified sub-functions: Prepare Ground Ops, Recover, Operate GSE/Facilities, Prepare Flight Ops, Launch, Land, Fly, Reenter).
2. List the criteria that should be used to evaluate this subsystem's operating characteristics (nominal and emergency operating ranges) as they affect safety.

Maintenance

[The items in this section will appear in both the Data Synthesis section of the Supplemental Report and the specific Guideline Inputs volume concerned with Maintenance.]

1. Discuss the key maintenance actions associated with this subsystem and its connections to other systems (either on the vehicle or with GSE/facilities) that may affect safety. Identify the affected sub-functions within Maintenance (out of the 5 identified sub-functions: Perform Un-scheduled Maintenance, Perform Scheduled Maintenance, Perform Turnaround Maintenance, Perform Interval Driven Maintenance, Perform Parts/subsystem Life-cycle Replacement*)*
2. List the criteria for maintenance activities for the subsystem needed to ensure operating characteristics are maintained as they affect safety

Training

[The items in this section will appear in both the Data Synthesis section of the Supplemental Report and the specific Guideline Inputs volume concerned with Training.]

1. Identify any special training needed to operate or maintain this subsystem.

2. Identify the personnel that would need to be trained (e.g. approval authority, flight crew, ground ops personnel, maintainers, technicians, etc.).

3. Identify special equipment or facilities may be needed for delivery of this training.

Approval

[The items in this section will appear in both the Data Synthesis section of the Supplemental Report and the specific Guideline Inputs volume concerned with Approval.]

1. Identify personnel (Ground Ops, Flight Ops, Maintenance) that require an FAA approval activity to operate or maintain this subsystem.

2. Identify the equipment, facilities, material, and procedures that require an FAA approval activity (out of the 4 identified sub-functions: Approve Training Fac/Equip/Mat, Approve Acceptance Fac/Equip/Mat, Approve Operations Fac/Equip/Mat, Approve Maintenance Fac/Equip/Mat).

Subsystem Interaction/integration

[The items in this section will appear in both the Data Synthesis section of the Supplemental Report and the General Guideline Input volume.]

1. Identify relationships with other on-board subsystems.
2. Identify relationships with GSE & Facilities.

Notes

[This section is designed to be a repository for related issues or technical concerns that may need further follow-up elsewhere in one of the deliverables or the overall research effort. It is similar in nature to the data collection/data synthesis accomplished in the DO2 effort that gave rise to the Special Topics sections in the final report. This section should include Licensing issues, especially any design or production considerations that should be passed to the licensing process for consideration (14 CFR 431)]

Generic Function Guideline Input Detail

The following questions are intended to address the what, who, when, why, where, how, and what effect on safety aspects for each function represented in the functional decomposition diagrams.

General

[Items 1 and 2 of this section are targeted for inclusion in the supplemental report under Data Collection – Functions. The remaining content will appear in both the supplemental report (Data Synthesis) and the individual Guideline Inputs volumes.]

1. What is the function?
2. Identify sources of information for this function. Where possible, note other functions or subsystems also addressed in the source.
3. Identify who typically performs the function and what the role, if any, of the FAA should be in providing oversight/approval of the function?
4. Provide a process flow diagram for the execution of this function. Include major variants where applicable.
5. List the major issues associated with the performance of this function that may affect public safety.
6. List any special capabilities and/or limitations imposed on overall operations and maintenance by this function.
7. List any inter or intra agency issues associated with this function.

Cross-Correlation

[This section is targeted for inclusion in both the supplemental report (under Data Synthesis) and the individual Guideline Inputs volumes.]

1. Identify and discuss relationships between this function and other functions or subsystems in each area.

2. List the potential (public) safety effects on other functions that result from the performance (normal and abnormal) of this function:
   a. Operations
   b. Maintenance
   c. Training
   d. Licensing/Certification
   e. Subsystems

Notes

[This section is designed to be a repository for related issues or technical concerns that may need further follow-up elsewhere in one of the deliverables or the overall research effort. It is similar in nature to the data collection/data synthesis accomplished in the DO2 effort that gave rise to the Special Topics sections in the final report.]

Endnotes

[1] Reusable Launch Vehicles Operations and Maintenance Top-Down Analysis Final Technical Report, RTI, September 30, 2002 (RTI Report No. 08087.002)
[2] "RPR # AST-01-543-X, Phase 1 – Licensing and Safety Requirements for Operations and Maintenance of Commercial Reusable Launch Vehicles.",FAA, AST-100, June 29, 2001
[3] Final Report of the Commission on the Future of the United States Aerospace Industry, Chaired by the Honorable Robert Walker, November 2002
[4] Final Report of the Commission on the Future of the United States Aerospace Industry, Chaired by the Honorable Robert Walker, November 2002
[5] SpaceRef.com, Commission on Aerospace Delivers Final Report and Findings President Bush and Congressional Leaders, Press Release Date Released: Monday, November 18, 2002, Commission on the Future of the United States Aerospace Industry, http://www.spaceref.com/news/viewpr.html?pid=9828
[6]http://www.lanceurs.aeromatra.com/connaissance/conferences/huntsville_2002/deneu.asp?planche_id=1
[7] 14 CFR Part 417
[8] Eastern & Western Range 127-1 (ver. 1997), 30th Space Wing and 45th Space Wing.
[9] Reusable Launch Vehicles Operations and Maintenance Top-Down Analysis, Final Technical Report, RTI, 9/30/03
[10] Generic spaceport Functions Definitions document from ASTWG breakout session, mar 2003
[11] Definition from Simulation Validation by Peter L. Knepeli and Deborah C. Arangno, IEEE Computer Society, 1993
[12] This international standard specifies the general characteristics, performance, design, test, safety, reliability, maintainability and quality requirements for ground support equipment (GSE) and systems intended for use at launch, landing, or retrieval-site installations or other locations that are the responsibility of the launch, landing and retrieval site. The standard does not specify how to design GSE, but establishes the minimum requirements to provide simple, robust, safe, reliable, maintainable and cost-effective GSE.
[13] This specification establishes environmental criteria for designing Aerospace Ground Equipment (AGE) in support of space systems. The test levels in this specification have been elevated to compensate for absence of combined environments during test, and to allow for variations in equipment and operating conditions.
[14] This standard contains suggested policies, procedures, and practices required to maintain mobile and fixed ground support equipment at airport passenger and cargo terminals. The principal purpose for ground support equipment maintenance is to provide the owner/user with safe, serviceable equipment, in good appearance, at minimal cost, and with minimum downtime. Maintenance programs initiated on ground support equipment must also conform to regulations controlling airport operations. This document has been divided into three sections corresponding to the three stages of equipment life; acquisition, maintenance, and disposal.

[15] This standard establishes preferred practice for the design of GSE used by or for NASA programs and projects. This standard is recommended for the design of nonflight hardware and software used to support the operations of receiving, transportation, handling, assembly inspection, test checkout, service and launch of space vehicles and payloads at NASA launch, landing, or retrieval sites.

[16] FAA System Safety Handbook: Practices and Guidelines for Conducting System Safety Engineering and Management, FAA (ASY), December 30, 2000